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Jaycar ELECTRONICS

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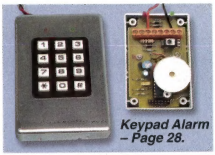

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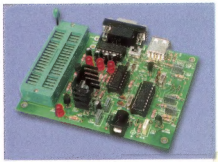

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PUBLISHER'S LETTER

Thunderstorms – nature's monster light show!

As we go to press, New South Wales is getting a fresh bout of drought-breaking rains over the state. In fact, it has been bucketing down over wide areas. No-one is complaining though; after such a severe drought, city dwellers are happy to endure the rain, in the hope that country districts are getting their fair share. But I enjoy it for another reason - I love thunderstorms.

We haven't really had a lot of thunderstorms in Sydney lately, having missed out on the usual summer storms because of the drought. So why do I like thunderstorms? Well, perhaps I had better qualify that. I don't actually like being out in them, getting wet. I am not keen on that at all. I am also concerned about damage to electrical and electronic equipment during storms, so that is another negative. If a big storm is coming close, I go around the house and disconnect just about everything that is practical.

The reason I love thunderstorms is the great spectacle - nature's monster sound and light show. I like to sit in a darkened room with the curtains open, watching the progress of storm cells as they move up the coast. And while lightning strikes to ground can be very spectacular, the real fascination is in the constant and ever-changing internal lighting of storm clouds - so-called "sheet lighting" or cloud-to-cloud discharges. In fact, even when storm cells are a very long distance away, so far that no thunder can be heard, the constantly flickering light in the clouds can be marvellous.

Just why is the electrical charge within the cloud bank changing so constantly? One reason is that each lightning strike causes the local charge distribution to be radically altered and it then has to equalise within the rest of the cloud. Another is that the storm cell is dynamic, with massive updraughts and down-draughts, as more moist air is sucked in.

I like to think of the charge distribution within a large cloud as akin to that on the ultor electrode on the back of your TV's CRT (or the moving plate in an electrostatic loudspeaker). This large sheet electrode is a poor conductor and each local discharge (ie, lightning strike) causes all the charge distribution to readjust (the sheet lightning). Nor does this happen instantaneously and it can take several seconds for the dislocation caused by one lightning strike to ripple all around the cloud mass which can be huge – perhaps 50km or more across in a big storm system. All this happens constantly and so we have a wonderful random light display.

And of course, each lightning strike that we see to ground is accompanied by an unseen equivalent discharge up into the stratosphere - the so-called "sprites" observed by astronauts. Sprites are a pinky, red colour, just what you would expect from an electrical discharge in a near-vacuum.

With all that going on and the enormous energy involved in the dumping of perhaps millions or even billions of tonnes of water onto the land, how can you possibly watch some trivial show on TV during a big storm? Turn it off and watch nature's vast and wonderful spectacle!

Leo Simpson

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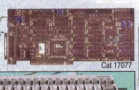

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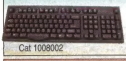

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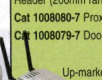

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Smart card article unnecessarily coy

In the January 2003 article on the Smart Card Reader/Programmer, I was surprised by your coyness in not wanting to supply the software! I simply do not believe what you say on page 18 about Australian federal law. I use exactly the same software in my Atmel programmer kits. It is trivial – serial port, I^2C, MAX232 to data I/O! The only difference is the Smart Cards are not in DIP packages (and they are Microchip, not Atmel brand).

All chip programmer software always has a Read option. So if you follow the same logic you would not be supplying microcontroller programming software because, like a pencil and paper, it could be used to defeat encrypted systems! Security issues with Smart Cards are well discussed on the web.

There is an excellent introduction to smart cards at:

http://egov.gov/smartgov/tutorial/smartcard_foyer.cfm

Peter Crowcroft,
DIY Electronics (HK) Ltd,
Hong Kong.

Credit to Edwin Armstrong

Regarding Andrew Woodfield's super-regenerative receiver article in December 2002 magazine, some credit is due to Major Edwin Armstrong, US Army, for his invention of regenerative, super-regenerative, superheterodyne and FM receivers, in the early valve age of electronics. Super-regenerative receivers were used extensively in WW2 due to their high sensitivity at VHF and economy of valve numbers.

Their most important and numerous use was in VHF, IFF (Identify Friend or Foe) transponders, fitted to Allied aircraft. Super-regenerative receivers were also used in portable battery operated VHF transceivers and radar beacons.

Back to Andrew Woodfield's super-regenerative circuit, a single turn coil link coupling to L1 is another way of connecting an external antenna to the detector's inductor.

On another subject, Garry Cratt's article on satellite TV (also in the December 2002 issue) made the statement that the BBC no longer transmits on shortwave. The BBC can still be heard in Australia on shortwave, although not intended for us, directly in English.

J. Grace,
Kirrawee, NSW.

Comment on Serviceman's Log

In regard to the Sony television from South Africa in the Serviceman's Log section of your January 2003 issue, the set is described as having an FM receiver built-in, yet only being mono. The reason for this (and I have a Philips set with this feature from South Africa) is that you can broadcast TV programs in more than one language. While one language is attached to the main TV signal, the FM tuner can pick up another.

In Australia, the system was probably used for stereo though the two sound channels would be used simultaneously on two separate speakers. I hope this clears it up for you.

I would also like to mention that your SC480 looks very good and that I will soon upgrade my amps! It is great that I won't need to buy another case, transformer, output transistors, caps, bridge, etc since the new one literally drops into the old one's place without much cost at all! Well done.

Rory Shillington,
via email.

Extending memory in VCRs

If we turn the power off at the wall socket instead of leaving our VCRs, etc on stand-by, we can save on our electricity bills. That is all very well but when we switch the power back on we have to reset the clock, or do we?

I have a Philips mono video which has a super cap to hold the memory for a short time. By adding a one Farad super cap to this I was able to extend this time to over 40 hours which suited my requirements. To get the same time on my Panasonic hifi video, I had to fit three one Farad super caps. I hope this is of interest.

Cyril D. Vickers,
Elizabeth Downs, SA.

Circuit Notebook policy

Would it be possible for you to publish an article concerning your magazine's policy on what it will or won't publish in your Circuit Notebook section

For example, will you publish valve circuits, improvements to existing designs or improvements to designs in long-dead magazines? Are you prepared to use two pages for one design submitted and how good does it have to be before you want to touch it?

As a matter of policy, everybody would like to know where they stand.

Gregory Freeman,
Mt. Barker, SA.

Comment: in general, we don't publish valve circuits, unless they are featured in the Vintage Radio pages. We would not rule out publishing improvements to circuits from deceased magazines; eg, Electronics Australia, ETI, Popular Electronics, AEM, etc.

Some designs featured have run over two pages (see this month, for example). How good does it have to be? Hard to answer – innovative, novel, clever, simple and complex circuits can all get a run.

Many homes have unsafe wiring

The Victorian union attempt to outlaw electrical hardware sales for home wiring installations is another piece of stupidity. I feel that far too many homes are sold without the buyers being aware of the state of the wiring and a certificate of compliance should

be issued. The same should be done for rental properties every four years or so.

As a dishwasher serviceman, I have seen many instances of dangerous points wired behind the dishwasher, with it in turn being tiled into place after installation. This makes removal and disconnection from live wiring impossible, as well as extremely hazardous in case of fire or malfunction. You could not turn these off if you wanted – the only way would be via the main fuse box.

John Vance,
Melbourne, Vic.

Government/union bashing?

I have been reading your Publisher's Letters in recent issues. What on earth are you on about? Is this a bit of government/union bashing I detect. Where are your facts to support your statement that electricians are less skilled than TV/washing machine, etc repair persons?

At least to become an electrician you must attend an accredited TAFE course and pass the appropriate competency levels before your can call yourself an electrician. Have all repair people completed and passed the appropriate qualifications before setting up to call themselves qualified repairers?

I looked up the Queensland ESO site and read through the requirements of the legislation. It is not an Electrical Contractor's License that they are asking for but an Electrical Contractor Business License. You know of the "Gold Card" license, so that the customer has some protection against shoddy workmanship. No Gold Card, no work. Someone has to regulate these businesses and this seems to be the generally accepted method to have a government body to do this.

You also make light of the fact that no service person has been electrocuted on the job but I wonder how many of his/her customers have. How would you know this, because without any regulation they are not required to report any incidents? But an electrical contractor must under OH&S legislation report all incidents, or risk fines and loss of license.

I think you are missing the point of the legislation, which is to introduce some accountability on the service person part and to provide some guarantee to the paying customer that their work is of a minimum standard.

I could go on but then you might think I was just a disgruntled unskilled electrician.

Jeff Ezzy,
via email.

Comment: all electrical deaths are reported and investigated, no matter what the cause or circumstances. Our statement was that "there probably never has been a fatality because of an appliance fault caused by a repairer" (page 4, February 2003).

It turns out that there is just one recorded electrical fatality, due to a wiring fault in a repaired appliance – in a vacuum cleaner! This sole fatality is the only one recorded in Australian records going back some 50 years, in a population now approaching 20 million people. Plainly, this is a very tiny problem!

Another method for de-sulphating batteries

In the Circuit Notebook section of the February 2003 issue, you showed a circuit which claims to reverse sulphation in lead-acid batteries and you expressed some doubt as to whether it would be effective.

There is another method which reverses sulphation by using chemical regeneration. This method has been around for many years and definitely works. I used it on the 6V batteries used to power the underwater lights of flounder fisherman in the small coastal country town in which I lived in the early fifties.

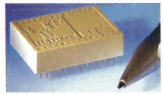
The problem was that as soon as the flounder season ended, the batteries would go on the shelf in the shed and be forgotten. When the next storm started, not only would they be flat but also well sulphated.

Using the method described in "Salving Accumulators – A Simple Method" (Radio and Hobbies in Australia, December 1942) definitely did the job and yours truly made a little money as well.

David Allen,
Findon, SA.

Comment: we have the article on file. The method involves replacing the battery acid with sodium sulphate and

The Tiger comes to Australia



The BASIC, Tiny and Economy Tigers are sold in Australia by JED, with W98/NT software and local single board systems.

Tigers are modules running true compiled multi-tasking BASIC in a 16/32 bit core, with typically 512K bytes of FLASH (program and data) memory and 32/128/512 K bytes of RAM. The **Tiny Tiger** has four, 10 bit analog ins, lots of digital I/O, two UARTs, SPI, I²C, 1-wire, RTC and has low cost W98/NT compile, debug and download software.

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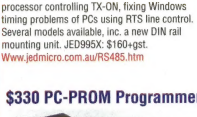

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then giving a long charge. The battery is then washed out thoroughly with distilled water and refilled with fresh sulphuric acid.

AC operation of halogen lamps

Just a note to thank you for the review of "Motor Home Electrics & Caravans" in the February 2003 issue.

The halogen globe life issue is a curious one. I recollect way back that they were only recommended for AC on the grounds that was necessary for the depletion cycle or something – but they are used extensively on DC (including by me). The (alleged) problem concerns only the 12V 10/20W globes – mainly the 10W units. Car headlight and other such globes are designed to run on 14.2-14.4V. They are far more rugged and as you say, work fine.

The boat people are adamant about this issue. You'll find any number of references to this in marine electrical manuals. We could all be wrong of course – the problem might be salt water, dirty DC or something else!

Collyn Rivers
www.caravanandmotorhomebooks.com

Loves the PICAXE article

Just wanted to say thanks for the a great article about a great little chip. As soon as I had read Stan Swan's February article about the PICAXE chip, I went onto the UK site and ordered some. They arrived in six days.

I set up the LED flashing experiment after dinner and it worked straight off. I then set about experimenting with it and now have it sending CQ in Morse. I can see a great future for this little chip and look forward to many more uses for them down the road.

Eric van de Weyer, VK2KUR,
via email.

Possible cruise control problem with LED tail lights

With regard to the LED tail lights featured in the March issue, you refer to the brake light out sensors giving incorrect readings if these are used. There is another piece of automotive equipment which may be adversely affected by the LED tail light replacements, namely cruise control (CC).

Many cruise control units use the brake pedal and stop lamp globes to sense when the brakes of the car have been applied, disengaging the CC unit. They use the cold resistance of the globes to take a sensing input to ground which allows the CC to be engaged. When the brakes are applied, this input goes to +12V as the lamps light, disengaging the CC.

If all the globes are replaced with LED units, the CC may not work as the input might not "see" a low resistance to chassis.

In regards to "lamp out" sensors and CCs, probably the best solution is to fit small globes in parallel with the LEDs and hide them inside the car. The rating of the lamp would be selected to allow for these sensors to work but this tends to defeat the purpose of the exercise (except for the faster turn on time of the LEDs).

Brad Sheargold,
via email.

Electrical contractors often negligent

Once all Queensland electrical appliance repairers are licenced as contractors, will it eliminate incidences of negligence investigated by the Electrical Safety Office? I don't think so! In reviewing electrical accident reports, I note that contractors and their employees are amongst the worst offenders on safety issues, often resulting in electrical workers, non-electrical workers and members of the public suffering electrocution.

Requiring all repair persons to become contractors will only skew the statistics, with less accidents due to "unauthorised" work and more accidents caused by "licenced persons". I can even visualise more accidents because the public will not pay high prices for a "licenced contractor" to replace faulty switches, power cords, etc and will just wrap them in more sticky tape and hope for the best.

Still, at least the Queensland government coffers will benefit from the increased licence revenue.

If states do go ahead and regulate that only contractors may purchase and install electrical products, thus cutting out the home handyman, I wonder if the manufacturers like Clipsal and HPM, and retailers like K-mart, the hardware stores, etc will suddenly wake up as they lose their lucrative DIY market? (Name supplied but withheld at writer's request).

LED lighting is irresponsible

Five point five metres! With the Road Authorities, NRMA and others trying to educate the public to drive in a responsible manner, with a rule of thumb, suggesting not travelling closer to the car in front equal to two seconds at the speed in question, the distance at 100km/h is a reasonably healthy 55 metres.

Taking the official view that some people have a reaction time of up to 1.5 seconds, the March 2003 article on "LED Lighting For Your Car" is not in the public's interest.

It is up to the driver in front to drive his vehicle at a speed and so placed that the risk from a shunt from a following car is minimised – not place his faith in bright lights that give a mathematical saving of 200 milliseconds. Having the advantage of a 60-year history of driving Australia's roads and never been hit in the rear, your article belongs in the rubbish bin.

Jim McCloy,
via email.

Comment: how can you seriously suggest that our article advocates driving too close to the driver in front? Read the article again to discover what we actually said.

Regardless of which type of stop lights are fitted, safe following distances will always be required. However, anything which gives you extra braking time in an emergency must be worthwhile.

Your statement that it is up to the driver in front to maintain a safe following distance is puzzling. Surely that responsibility lies with the driver behind? We also understand that the rule of thumb is to leave a three-second gap to the car in front, not two seconds. **SC**

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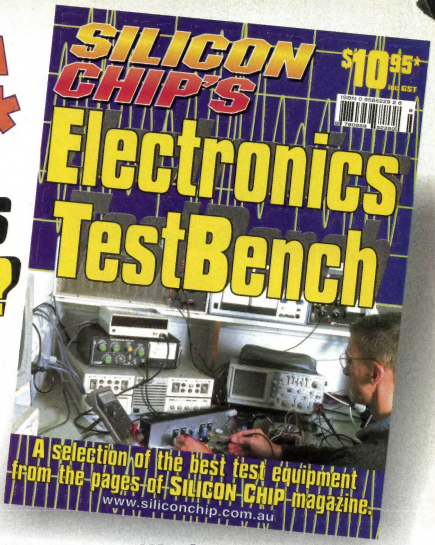

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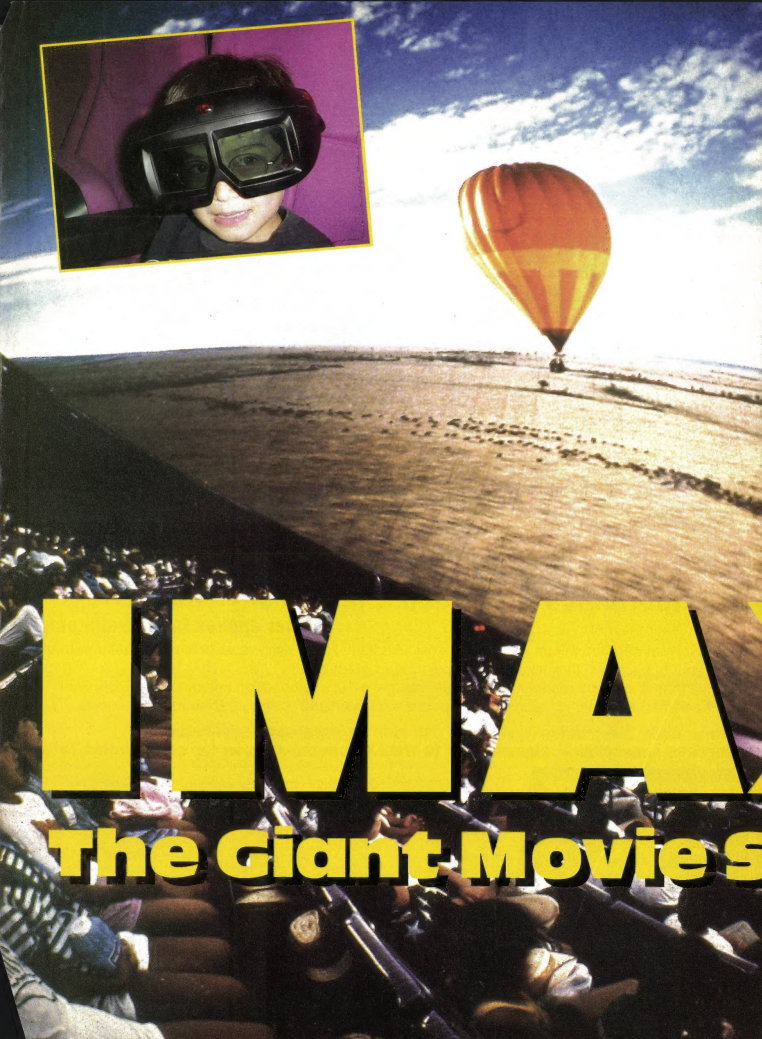
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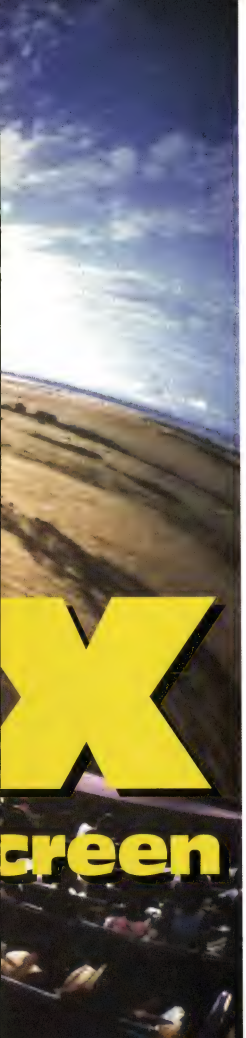


Most readers have seen or heard about IMAX – the giant screen which can show movies in two and three dimensions (3D). This is the story of IMAX.

By BARRIE SMITH

PEOPLE ARE ENTRANCED with the big picture. In the early 1800s, Robert Fulton amazed audiences with his Cyclorama, a 16-metre high by 130-metre long painting that ran on rollers. The Lumiere brothers, not content with their pioneering 35mm film efforts, even managed to screen movies shot on 75mm film.

The 3-strip 65mm Cinerama process emerged in 1963, quickly followed by CinemaScope, VistaVision, Circarama, Technirama, Todd-AO and so on. Then came IMAX, a process that side-stepped the perception that audiences just wanted a big, wide picture.

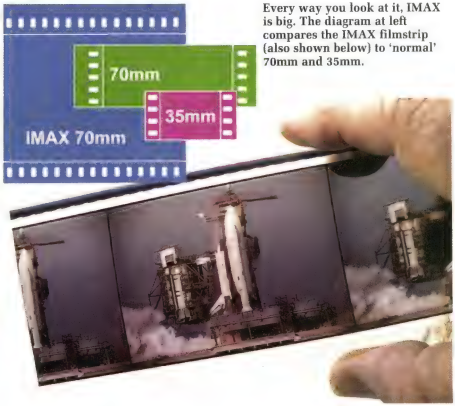
Instead, the Canadian developers of the IMAX process headed for a screen picture that was just huge . . . very enveloping, very sharp and almost grainless, swamping the eye's peripheral vision; the field of vision is 50° vertical and 130° horizontal.

The IMAX camera uses 65mm negative film (from which 70mm projection prints are made). An IMAX film frame measures 48.5mm high by 69.6mm wide – a total area of 3375.6mm^2, over 10 times the frame area of conventional 35mm film.

Each IMAX film frame has fifteen perforations; a single frame races past the camera's aperture in 6 milliseconds; each second, 1.7m of film rips past; each minute exposes an expensive 102.6 metres of Mr Kodak's famous product.

A Cumbersome Beast

The discipline required in shooting an IMAX production is extraordinary. A 2D camera can be a cumbersome beast, even though there are smaller units for difficult location work. In IMAX, it is advisable to avoid pans or quick movements of the camera. Sharpness and the utmost depth of



Every way you look at it, IMAX is big. The diagram at left compares the IMAX filmstrip (also shown below) to 'normal' 70mm and 35mm.

Australian producer, Michael Caulfield (seated right) working on his film "Horses – The Story of Equus".

field is essential. Then there is the 3D camera, with its doubled film path and optics!

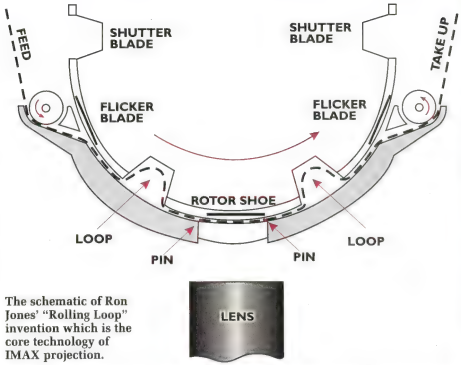
Australian producer, Michael Caulfield has made two IMAX films: "Africa's Elephant Kingdom" and "Horses – The Story of Equus". In his experience "Wherever you turn in the IMAX format you're going to have problems . . . the camera is very big; this means very, very big mechanical gearing and cogs to pull the film past the lens at a stable rate.

"There are really only about 10 decent cameras in the world. They're worth a lot of money and they're also quite peculiar, so you have to send your camera assistants and focus pullers, if they've never worked with one before, to Toronto to learn it.

"You have to book the camera a long way ahead", Caulfield cautions. "You have to be able to schedule and re-schedule with a fair degree of certainty. And of course if you're making

The Sydney venue at Darling Harbour is profitable, relying on 65% audience attendance of Sydney residents plus local and overseas tourists as well as school groups.

In Sydney's IMAX theatre biobox, chief projectionist Tim Gunn fires up the 2D/3D projector.



The schematic of Ron Jones' "Rolling Loop" invention which is the core technology of IMAX projection.

natural history films that can be very difficult".

He has found the cameras are "surprisingly, very reliable. They have to be heavy-duty, otherwise yanking that amount of film through, they'd fail".

"However, if they do 'go', explode inside or the film snaps, they internally haemorrhage. It takes you ages to fix them".

Costs are another matter. "Every roll of film is 300 metres or three minutes long. Film and processing cost is about US$8000 for each roll. That's just stock cost and processing. If you want to do print-downs to 35mm, which we do for everything we shoot, then that's another cost altogether".

I asked him what is the shooting ratio (raw film shot vs final edited length) on a typical film. Caulfield: "A normal natural history film is around 30:1. We shoot around 11:1. You have to. You just can't afford any more".

"And you have to make a lot of

IMAX rotor paths: the right eye is uppermost and its aperture slightly advanced on the left. In these shots, film travels right to left.

Ron's Loop

The late PRW (Ron) Jones created a rolling-loop film transport for projectors in the '60s, the invention revealed in a paper given at the SMPTE in 1969. The young IMAX group snapped up the patent for its process, having realised that while you can whip 100 metres or so of 65/70mm film past a camera gate's intermittent movement once, it won't survive repeated journeys in a projector.

In the projector, the primary film drive is by means of a 952.5mm diameter rotor with eight windows and driven at 180 RPM by a synchronised 3-phase motor. Pulsed air jets at each of the windows form a loop or wave in the film as it passes the input sprocket and then advances the film past the aperture; here a cam and four registration pins momentarily hold each frame in the plane of the aperture against a curved quartz glass rear lens element. Steadiness on screen is high – less than 0.04% in any direction; print life can run to at least 1500 showings.

Norman McLaren

Scottish-born, Canadian resident, Norman McLaren was determined to explore new techniques. The late 1940s, early 1950s saw him experiment with animated 3D films and hand-drawn films, scratching and painting not only the film image but scribbling and gouging over the soundtrack area to make his own audio effects. Still well ahead of his time.

Wescam

Arguably the world's best gyro-stabilised camera platform, Wescam was first used in 1969. Today there are hundreds used worldwide by TV news crews and police video units. But the really heavy use is by a handful of 35mm film units in major world capitals.

Its capabilities to produce rock-steady shooting at low frame rates (12fps for example) and with long lenses (such as a 250mm telephoto) has helped the creation of memorable images in the cinema. The Wescam mount uses three high speed gyros that control the roll, pitch, and yaw axes; a fourth gyro attends the vertical axis and helps further stabilise the camera platform when acceleration, deceleration and G forces impinge on the mount.

Clever dual feed/takeup spools enable the next film to be nearly laced up, ready for showing.

allowances as well because you don't really 'see' the film until you've 'locked off' the edit. You can't afford to print out everything you've shot onto 70mm. So what happens is that every so often you'll print up a roll or two of shots you may be concerned about.

"You cut the film on a digital editing machine from 35mm print-downs. That's all fine and well but you don't really know until the film is finished and locked off. The lab strikes a first answer print and then you look at it and you go 'Oh my God!' There may be a shot with a tourist van in it or the shot has a bit more shake than you thought, which renders it unacceptable. So you need to have an allowance in your budget to go back and reshoot".

Sydney IMAX Cinema

The purpose-built Darling Harbour building is owned by MTM Entertainment Trust. The projection equipment is owned by IMAX Canada and leased to the Sydney company while the films are rented.

There are IMAX cinemas in Sydney, Melbourne, Dreamworld at Coomera in Queensland and one in Townsville. The Sydney venue is the eighth most successful IMAX theatre in the world, most times running in the top three or four. About 65% of its business comes from Sydney metropolitan residents, 15% from school groups and the remainder a mix of domestic and international tourists.

Sydney IMAX has found that 3D titles are proving more and more popular. As Mark Bretherton, Sydney IMAX Marketing Manager, says: "A 3D film can actually be weaker in terms of content but it will draw more. The most successful films in 2001 were two 3D films, "Cyberworld" and "Haunted Castle", plus a 2D film called "Shackleton's Antarctic Adventure" (still running in early 2003) and probably one of the best crafted IMAX films I've seen".

Projection Top Gear

Perched way above the audience in the Sydney IMAX theatre is the projection biobox, operated on most days by chief projectionist, Tim Gunn. He well remembers the days of short reel changeovers and, in one way, welcomes IMAX's approach where the loaded film will run 40 minutes or more from the one roll. However, the call for "action stations" at reel's end sees him race into top gear.

A 2D print can weigh around 100kg so a forklift is used to trolley the film rolls around the biobox. The Sydney projector is a 2D/3D machine, fed by two film paths – or four for a 3D title. The films are threaded all the way to the projector input. At the end of a screening, the machine is stopped and the tail unlaced. Then the lacing up of the new print(s) commences.

Normally the 2D and 3D films alternate; in this case Tim will take "a good 10 minutes" to make the change-over. This entails the lace-up and the change of projector optics and back condenser lens as well as a clean-up of the film path itself.

The lenses are different for every theatre, depending on the projector-screen throw.

Sydney has a Leitz Canada 38mm 2D lens and two 52mm lenses for 3D; the projected 3D screen image is

Yes, you need a forklift to move the 100kg film loads.

IMAX in space: Expedition 1 Commander Bill Shepherd (left, pale shirt) and Flight Engineer Sergei Krikalev (right) frame and focus a shot on the Video Display of the IMAX 3D cabin camera just before filming in the U.S. "Destiny" lab module of the Space Station. (Photo: NASA).

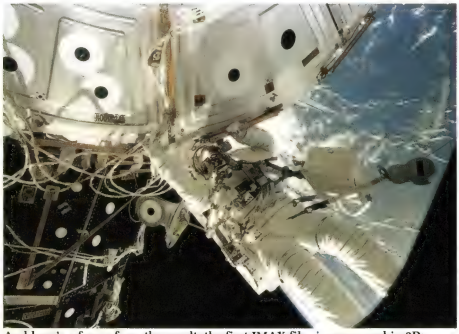
smaller, because it "eats a lot more light", thanks to cross-polarisers on the projector and those in the audience viewing headsets. Light loss is estimated to be at least 30%.

Early on, the Sydney cinema used the original electronic 3D system which employed pulsed LCS (Liquid Crystal Shutters) as well as the cross polarisers. This method has given way to polarisation due to audience theft of the headset battery packs!

Lamp power is from two 15kW xenons; the illumination is directed to the film aperture/lens point by means of a folded light path, using two air-cooled mirrors.

The projector itself is massive and aside from the dual light source and lens assemblies, has a double deck rotor to transport the films (see "Ron's Loop"). The right eye film is uppermost.

An interesting feature of the setup is that the left-eye film is projected a few degrees of rotation before the other



And here's a frame from the result, the first IMAX film in space and in 3D: Space Station 3D.

IMAX

First shown at Expo '70 in Japan, the wide-screen process has been with us for decades and one of its earliest achievements was the 1984 Challenger and Discovery missions which were chronicled by an IMAX camera carried on three missions. The 14 astronaut crew were trained as movie cameramen for five months. The camera was the largest ever to travel in a space shuttle and needed special accommodation in the zero-G conditions.

The whole scheme, comprising IMAX cameras, projectors, theatre design and sound system, was conceived in Toronto, Canada with virtually no input from Hollywood. A specialist Norwegian engineer built the first camera, the camera and projector lenses came from Germany and Japan; the first projector was built in Toronto – and the mechanical heart of it invented by Ron Jones, a Brisbane engineer. Generously, Hollywood recognised this innovative 'heart' – the rolling loop film transport – by awarding it an Oscar for technical achievement.

OMNIMAX

This is IMAX with the roof rolled back and first seen in 1973 in a US planetarium. A Leitz f2.8/29mm fish eye lens is used to throw a razor sharp picture onto the inside of a spherical section, similar to a planetarium. The picture overfills your peripheral vision. The Townsville OMNIMAX screen forms a 160 to 165° segment of a hemisphere. The screen and audience are tilted at an angle of 25°, with the projection lens located a short distance beyond the hemisphere's centre.

The Edge

The Edge, at Katoomba, NSW, is a purpose-built cinema, designed to run a 70mm format as well as 35mm movies. It was developed by ex-Disney veteran Ub Iwerks.

The format uses eight perforation 70mm film running vertically. Frame area is 1775 sq mm – 5.5 times that of 35mm at 319 sq mm.

More IMAX?

The IMAX process was described in much more detail in an article in "Electronics Australia", February 1972. SILICON CHIP can supply reprints of this article for $8.80 including GST and postage.

The original electronic 3D system employed pulsed liquid crystal shutters as well as cross polarisers. This method has given way to polarisation, not for technical reasons but due to audience theft of the headset battery packs!

film. This rotor offset (about 12° or 0.01 seconds approximately) allows the rotary shutter to expose the left lens and fire the left lens of the E3D viewer, while the right lens remains covered and the right E3D viewer LC lens is closed – then vice versa. The rotor offset ensures that the projected image is not partly obstructed by the rotor shutter.

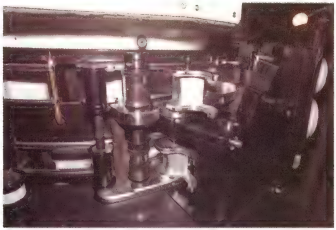
Multi-track sound

IMAX has had multi-track sound while suburban cinemas were still living in caves – so to speak! IMAX originally began with a 6-track 35mm magnetic dubber. The sound source is synchronised by projector drive shaft-encoded pulses.

The IMAX sound system is quite distinct from Dolby. It was developed by Sonics in Alabama, now owned by IMAX.

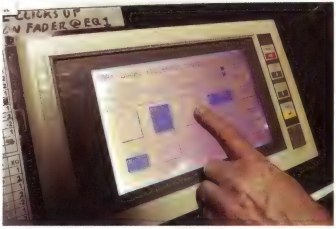
It is basically a 6-channel system with left, centre and right signals coming from the front; left and right signals from the rear, plus there is a channel issuing from the top of the screen for effects. Another channel, using a subwoofer with a stack of eight 15-inch drivers, derives its signal from all six channels.

These days, the magnetic dubber is still used as back up



Twin rotors and twin film paths are the secret to the electronic 3D on-screen image. The offset is about 12° or 0.01 seconds approximately.

As you might expect, most functions are computer controlled. Below is the projector LCD control touch panel.



but most times a setup of three digitally-synched CD players (Digital Disc Player or DDP) is employed, each carrying two channels per disc. Total running time is 80 minutes.

There is also a 6GB hard drive system, becoming important as a sound source for longer, feature-length films. Some films use all three sources. **SC**

Silent Running

Are you sick of the constant whirring noise your PC makes? Get rid of the racket by building a silent PC – by Peter Humphreys.

BACK IN October 2002, I wrote a letter to Mailbag about building a silent PC. What? A silent PC? Are you crazy? Look in any computer magazine and you will see "more power", "more GHz", "more fans", more noise!

Our computer lives in the living room where we can all share it without being unsociable. That's great but try watching a movie while a conventional PC is on and you'll soon tire of the constant whir from the cooling fans. Want proof as to just how much noise your PC makes? Just sit quietly with your PC for five minutes and then turn it off – the silence is deafening!

Yeah, maybe we should turn the PC off before watching a movie. But what if someone wants to use the Internet while the movie is on or use the computer for homework or to play games?

Alternatively, perhaps you have built an MP3 box. Doesn't the noise from the PC spoil the sound from your latest album? Or perhaps you want to add the PC to your home entertainment system so that you can watch DVD movies and listen to music.

Clearly, it's preferable to quieten down the PC so we can live with it instead of banishing it to the study.

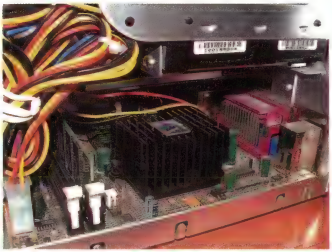
The "Silent PC" is not only very quiet but is compact and unobtrusive as well. The silver LCD monitor matches the keyboard and the brushed aluminium case.

Getting rid of noisy fans

Getting rid of noisy fans is a major step towards quietening any PC. However, that's not really practical in existing machines as disconnecting the power supply fan and/or the processor fan will quickly lead to frazzled components and catastrophic failure.

The best approach is to start from scratch and build a quiet PC from special components. This article describes a PC that is almost silent and, as a bonus, is extra small. The accompanying panel shows the parts used.

The total cost was around $2000, including the LCD monitor. The real magic is in the $220 motherboard. This price includes an Eden 533MHz



It's a tight fit inside the case but everything goes in neatly. The 90° PCI riser card is supplied with the case.

CPU and unlike other CPUs, this one runs quite happily without a fan. Instead, a large heatsink provides all the cooling that's necessary (and it does this without making a sound).

As an aside, I'm already thinking of swapping the bedroom TV for a computer monitor, plugging a TV tuner card into the motherboard and hiding the assembly in a drawer. With a cordless keyboard and mouse, it doesn't matter where the PC is!

The Parts Used In The Silent PC

- ClipperPro I-box Mini-ITX aluminium case with 180W power supply.
- VIA EPIA-5000 Motherboard with Eden 533MHz " fan-less" CPU
- 256MB PC-133 SDRAM
- Seagate ST360021A 60GB ATA100 hard disk drive
- Pioneer DVD-106S slot-load DVD-ROM drive
- Samsung 151BM 15-inch LCD monitor with built-in speakers
- Logitech cordless Navigator Duo (white/silver) keyboard and mouse.

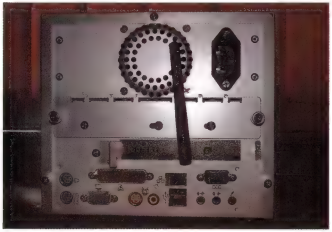
Special case

The special aluminium case used measures just 260 x 190 x 166mm and is very well designed. Air enters the holes in the lower front, passes over the power supply and motherboard, and then flows over the hard drive and out the rear exhaust.

The fact that the case is all aluminium helps with the cooling. The fan in the power supply was a noisy, small, high-speed type. Since the power supply is situated at the front of the case and the airflow passes right over it, I removed the power supply fan and cover which made a big difference.

(Editor's note: we strongly recommend that the original power supply cover be replaced with a new cover with improved ventilation; eg, with expanded mesh aluminium panels. Much of the circuitry inside PC power supplies operates at dangerously high voltages – ie, at 240V AC. They should always be fitted with a suitable cover, to guard against accidental contact. Similarly, a suitable cover should be fitted over the fan slots in the supply case, if the fan is removed).

The case fan is at the top rear of the case and is lost in the ambient noise in the house. This lone fan does a good job and nothing gets too hot. The BIOS reports that the fan is running at just over 2000 RPM and the PC has been running 14 hours a day, seven days a week for four months now without a hiccup. It's possible that if a



The lone fan at the back of the case operates quietly and does a good job keeping everything cool. Note the antenna – this is attached to the wireless LAN card which occupies the sole PCI slot on the motherboard (via a 90° PCI riser card).

The VIA EPIA-5000 motherboard comes complete with an embedded Eden 533MHz "fan-less" CPU (shown here without the heatsink). It also features integrated graphics, 10/100 ethernet and Sound Blaster Pro compatible sound.

power supply from a notebook computer was used, the PC could run completely "fan-less".

Via motherboard

The EPIA-500 motherboard from VIA comes in the ultra-compact Mini-ITX form factor and is claimed to be the world's smallest. It measures just 170 x 170mm.

Just about everything is integrated onto this board: VGA video, VIA 10/100 Ethernet LAN, Sound Blaster Pro compatible sound with S/PDIF output, two IDE Ultra DMA 33/66/100 connectors and all the other standard motherboard connectors.

Basically, the Mini-ITX motherboard is intended for "entry level" PCs, thin-clients, wireless network devices, digital media systems, set-top boxes and more. It is also becoming increasingly popular with enthusiasts due to its small size, quiet operation and low profile (the I/O ports are the tallest components on the board).

Want to know more? Have a look at **http://www.mini-itx.com** for information on how people have built PCs out of things like model cars, cigar humidors, motorcycle helmets, picture frames and more!

In my case, the key advantage of this VIA Mini-ITX motherboard was the "fan-less" VIA Eden processor. This CPU is embedded on the motherboard to reduce costs and streamline production but it does have one drawback – the CPU is not upgradable.

VIA processors have built a reputation for reliable, low-temperature operation. This is due to careful design and low power consumption – the Eden 533MHz CPU consumes just 2.8W. By comparison, recent Athlon CPU's consume about 70W of power!

By the way, a 667MHz Eden "fan-less" processor in now also available, along with a range of more powerful C3 processors which run up to 1GHz. The latter are fan-cooled, however. Despite this, the C3 range still run a lot cooler and have quieter fans than comparable Celeron CPUs.

Disk drives

The Seagate Barracuda ATA IV drive is one of the quietest around, due to the use of fluid bearings. It can only be heard if I place my ear near the case and watch for the HDD LED!

The DVD drive makes the most noise, especially at high speed. That's par for the course – all DVD and CD drives make a lot of noise.

If the PC is to be used standalone, a CD-RW or combination drive (CD, DVD and CD-RW) is recommended. My motherboard doesn't have a floppy drive interface but the latest mother–boards now feature this instead of a second IDE interface.

Wireless LAN

A wireless LAN card fills the single PCI slot via a 90° PCI riser card (supplied with the case). One good thing about the VIA motherboard is the use of standard components. Many other "small PC" solutions use laptop components and these can be expensive.

LCD monitor

A Samsung 15-inch LCD monitor (silver) was chosen to complement the brushed aluminium case used for the PC. This has built-in speakers, in keeping with the tidy appearance.

Fast enough

With CPUs now running at 2GHz or more, a 533MHz PC might sound rather slow by modern standards. However, for everyday home (and probably business) use, it's fine – at least my applications. I use it everyday for email and web browsing – and for playing Solitaire of course!

No more beige boxes for me!

Footnote: although we haven't tested it, **Microgram Computers** sell a 300W low-noise power supply with a thermostatically-controlled fan (Cat. 8957). It's well worth checking out if you want to build a silent PC. Enquiries to (02) 4389 8444 (see ad on page 3). **SC**

Useful Links

http://www.viavpsd.com/product/epia_mini_itx_spec.jsp?motherboardId=21
http://www.seagate.com/cda/products/discsales/marketing/detail/0,1081,383,00
http://www.pioneeraus.com.au/multimedia/products/dvd-rom/dvda06s/dvd-106s_116.htm
http://www.samsung.com.au/samsung.asp?cat=52&obj=650
http://www.mini-itx.com

Clean up your video signals with this:

Video-audio booster for home theatre

If your home theatre setup involves sending video signals over fairly long cables, you'll really appreciate this project. It's a wideband amplifier that can boost both composite and S-video signals, or even component video signals with the right cables. And it handles stereo audio signals as well.

By JIM ROWE

WHEN SETTING UP a home theatre, there's often a need to run fairly long video cables between your signal sources (DVD player, VCR and/or laserdisc player) and your big screen display. The reason for this is simple - it isn't always convenient to have the signal sources and the display at the same end of the room.

Of course, there's no great problem feeding audio signals over long cables, provided that the cables are of reasonable quality. However, that's not the case with video signals due to their much greater bandwidth. Video signal frequencies can range up to 5MHz or more (as against just 20kHz for audio) and can suffer quite noticeable degradation when fed through cables longer than about five metres.

This signal degradation is due mainly to cable capacitance. This causes high-frequency losses and occurs even when you use high-quality coaxial cable that has been correctly terminated at each end. The resulting pictures lack contrast and colour saturation, and also become noticeably "softer" (ie, lacking in fine detail) due to the lower bandwidth.

Video booster

The best way to tackle this kind of problem is to use a video "booster" every five metres or so. Basically, you take a 5-metre cable run and plug it into the booster – essentially a wideband video amplifier. The booster

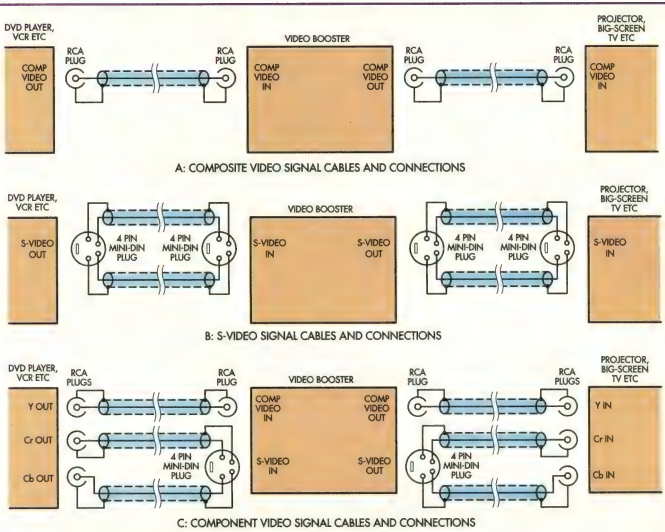


Fig.1: this diagram shows how the video booster is connected for composite video signals (top), S-video signals centre and component vide signals (bottom). It's basically a matter of buying (or making up) the necessary cables.

restores the incoming signal so that it is close to original before feeding it to the next 5-metre cable run and so on.

A booster for conventional "composite" video signals needs just a single wideband video amplifier channel. However, if you want to take advantage of the higher quality available from the "S-video" output of your DVD player, the booster needs two channels. That's because, in S-video, the luminance ("Y") or black-and-white picture information is not combined with the chrominance ("C") or colour information. Instead, the two signals are fed along separate cables to prevent them interacting – see Fig.1(b).

The video booster described here can handle either composite or S-video signals as required, because it uses an IC which actually contains four wideband amplifier channels. This allows us to devote one channel to the composite video input and output, while two more are dedicated to the S-video input and output sockets. This means that there's no switching and the composite video and S-video channels can even be used at the same time; eg, to pipe composite signals to another room while you're watching S-video signals to your home theatre display.

The fourth channel is spare and can only be accessed internally.

What about handling the even higher quality "component video" signal outputs? With this type of signal, as well as the luminance (Y) being kept separate, the two "colour difference" signals (R-Y or "Cr" and B-Y or "Cb") are also kept separate – ie, instead of being combined as the chrominance (C) signal.

If your DVD player provides these outputs and your display can also handle them, the video booster can help here too. All you need to do is buy or make up some adaptor cables, so that the three component video signals can be fed through the three main booster channels – see Fig.1(c).

Audio amplifier

As well as the video amplifier channels, the booster also includes a pair of low-noise audio line amplifiers. This means that it can also be used to handle any stereo audio signals which accompany the video, so these too will reach the far end of the cables in good condition.

Probably the main use for the audio channels will be where you're feeding the video and audio to a different room. They'll also come in handy if

Parts List

1 PC board, code 02104031, 117 x 102mm
1 plastic instrument case, 140 x 110 x 35mm
2 PC-mount 4-pin mini-DIN sockets
6 PC-mount RCA sockets
1 PC-mount 2.5mm concentric male "DC" connector
1 9V AC plugpack (500mA) with 2.5mm female connector

Semiconductors

1 MAX497 quad video amplifier (IC1)
1 LM833 dual op amp (IC2)
1 LM7809 +9V regulator (REG1)
1 LM7909 -9V regulator (REG2)
1 LM7805 +5V regulator (REG3)
1 LM7905 -5V regulator (REG4)
1 3mm green or red LED (LED1)
2 1N4004 1A diodes (D1,D2)

Capacitors

2 2200µF 16V RB electrolytic
2 100µF 16V RB electrolytic
2 10µF 10V RB electrolytic or tantalum
2 2.2µF 35V TAG tantalum
2 1.0µF MKT
2 220nF MKT
4 100nF monolithic ceramic

Resistors (0.25W, 1%)

4 100kΩ	8 75Ω
2 47kΩ	2 10Ω
3 1kΩ	

Where to buy a kit

The design copyright for this project is owned by Jaycar Electronics. Complete kits will be available from Jaycar Electronics by the time this article appears in print.

you need to send one or more of the signals in a 5.1, 6.1 or 7.1-channel surround sound system to remote power amplifiers; eg, you might want to send the SB (surround back) signals from your 6.1/7.1-channel decoder to the rear of your home theatre room, to drive a power amplifier for the rear centre speaker.

Alternatively, you might want to drive an active subwoofer with the LFE (low frequency effects) channel signals.

Presentation

As you can see from the photos, the booster is very compact. Everything fits in a small ABS instrument case measuring just 140 x 110 x 35mm. Power comes from a 9V AC plugpack.

Incidentally, Jaycar Electronics will be making a complete kit for the booster available, so you should be able to build it up very easily and at an attractive price.

The A/V output sockets are all accessible from the rear of the unit. They include a 4-pin mini-DIN socket for the S-video signals, plus three RCA sockets for the composite video and left & right channel audio output sockets. The socket at far right is the DC power connector.

How it works

The booster's video amplifier channels are all provided by IC1, a Maxim MAX497. This high-performance device is designed expressly for handling video signals. It includes four closed-loop buffer amplifiers, each operating with a fixed voltage gain of 2.0.

Other features of the MAX497 include a full-power -3dB bandwidth of over 200MHz, exceptional gain flatness (±0.1dB up to 120MHz), low distortion, very low differential phase/gain error between the four channels and the ability to drive four back-terminated 75Ω (or 50Ω) output cables simultaneously.

As shown in Fig.1, we're using one amplifier for the composite video channel and another two amplifiers for the Y and C channels for S-video. Each amplifier has a 75Ω resistor across its input and these ensure correct termination of the cables from the video source. In addition, 75Ω resistors are used in series with each output to give correct "back termination" of the output cables.

As mentioned, the amplifiers in the MAX497 have a feedback-controlled gain of exactly two. This compensates for the attenuation produced by the interaction between the back termination resistors and the termination resistors at the far end of the output cables.

In effect, the Video Booster "restores" the incoming signal before feeding it to the next cable segment.

The input and output connections to the composite video amp channel are made via RCA sockets, as these are now standard for domestic equipment. Similarly, the connections for the S-video channels are made via 4-pin "mini DIN" sockets, as these too are the accepted standard for S-video.

Note that the fourth "spare" amplifier in the MAX497 is also provided with input and output termination resistors. This is done to ensure that it doesn't interact with the three active channels. The resistors will also make it easy to use the spare channel if you ever need it.

The two audio line amplifier channels are provided by the two halves of an LM833 dual low-noise op amp (IC2). As shown, these two stages are identically connected as non-inverting buffers, with the 100kΩ resistors providing negative feedback for a gain of two.

The performance of these audio buffers is quite respectable. They have a frequency response from 30Hz to 120kHz at the -1dB points, a THD (total harmonic distortion) below .006% for 2V RMS output, a signal-to-noise ratio of better than 91dB relative to 2V RMS output, and an output clipping level of just on 14V peak-to-peak (5V RMS).

The audio buffers operate with a gain of two to ensure sufficient signal to drive your remote power amplifiers, etc. However there may be cases where even this small amount of gain could cause problems - producing distortion due to input stage overloading, for example.

If that turns out to be the case with your particular application, there's a simple modification which can be done to solve the problem. All you need do is remove the 100kΩ resistors connecting pins 2 and 6 of IC2 to ground. This turns the buffers into unity-gain voltage followers, increasing the overload margin by 6dB.

Power supply

The power supply section is quite straightforward, even though the video and audio amplifiers require four separate DC supply rails. The MAX497 requires ±5V supply rails, while the LM833 require ±9V rails.

Because the overall current drain is quite low (about 100mA total), two simple half-wave rectifier circuits (D1 & D2) are used to derive nominal ±12.8V DC rails from 9V AC plugpack. These rails are filtered using two 2200μF capacitors and then fed to 3-terminal regulators REG1 and REG2.

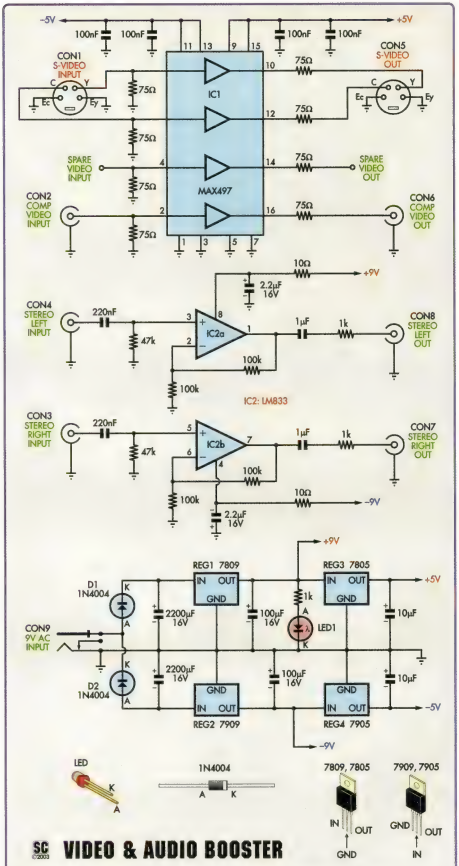
REG1 and REG2 produce the +9V and -9V rails respectively. They also drive 3-terminals regulators REG3 and REG4 which produce the ±5V rails. LED1 is driven from the +9V rail via a 1kΩ current-limiting resistor and provides power on/off indication.

The associated 100μF and 10μF capacitors are used to filter the regulator outputs. The ±9V supply rails are then further decoupled using 10Ω resistors and 2.2μF capacitors before being fed to IC2. Four 100nF capacitors provide additional filtering for the ±5V rails to IC1.

Construction

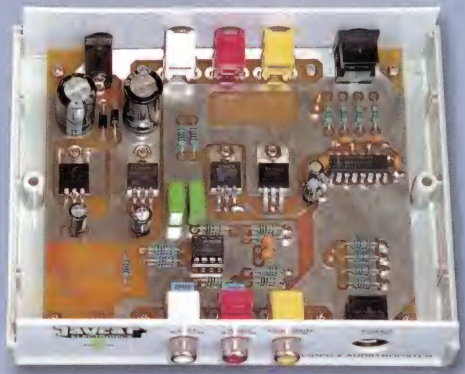
All the parts are mounted directly on a small PC board, so the unit is easy to build. This includes all the connectors, so there's no off-board wiring at all inside the booster box.

The PC board measures 117 x 102mm and is coded 02104031. It's double sided, with copper tracks on both top and bottom, but the top pattern is mainly an earthed ground plane. Only a handful of component leads are soldered to this top pattern, so we don't need a board with expensive



SC VIDEO & AUDIO BOOSTER

Fig.2: the booster circuit is based on a Maxim MAX497 quad video buffer IC (IC1). One amplifier in IC1 is used for the composite video channel, while another two are used for the Y and C channels for S-video. Op amps IC2a & IC2b (LM833) boost the left and right channel audio signals.



This photo shows how the power indicator LED is mounted on the PC board and pushed through a matching hole in the front panel.

Left: inside the completed booster unit. Keep all component leads as short as possible and be sure to solder the leads to both sides of the board where necessary, as indicated by the red dots on Fig.3.

plated-through holes.

Fig.3 shows the assembly details. Begin by fitting all the input and output connectors, as they often need a small amount of juggling and pin straightening before they'll mount without stress. Make sure that they're pushed down hard against the board, while you make the solder connections underneath.

Next, fit the two PC board terminal pins (for the input and output of the spare video channel), followed by the resistors and the diodes D1 and D2. Be sure to fit each diode the correct way around as shown on Fig.3.

Note that some of the resistors have their "earthy" ends soldered to the top copper pattern as well as to the pad underneath. The leads concerned are shown with a red dot on the board overlay diagram.

The four voltage regulators can go in next. These are all TO-220 packages and are mounted horizontally on the top of the board. Be sure to fit each one in the correct position, as all four are different and mixing them up could result in component damage when you apply power.

All regulator leads are bent downwards 6mm from the package body. This allows you to mount them by pushing the leads down through the mating holes and then fastening their tabs down against the copper using 6mm x M3 machine screws and nuts. The leads are then soldered to the pads underneath and, in some cases, to the top pads as well - see Fig.3.

The two 2200µF capacitors and the two 100µF capacitors adjacent to REG1 and REG2 can go in next. Make sure you fit all of these polarised parts the correct way around, as shown in Fig.3.

LED1 is fitted with its "flat" cathode side to the left (ie, furthest away from CON4). To install it, first bend both its leads bent down 90 degrees, 6mm away from the LED body. That done, it can then be soldered into place with its axis exactly 8mm above the board.

Power supply checks

At this stage, it's a good idea to check all of the power supply wiring by plugging the lead from your 9V AC plugpack into CON9 and turning on the power. LED1 should immediately light and you can now check the regulator outputs. You should get +9V from REG1, -9V from REG2, +5V from REG3 and -5V from REG4. These voltages are all measured relative to board earth and at the righthand pin of each regu-

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	4	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	3	1kΩ	brown black red brown	brown black black brown brown
❑	8	75Ω	violet green black brown	violet green black gold brown
❑	2	10Ω	brown black black brown	brown black black gold brown

Table 2: Capacitor Codes		
Value	IEC Code	EIA Code
1.0µF	1u0	105
220nF	220n	224
100nF	100n	104

lator, as indicated on Fig.3.

If everything is correct, you can switch off and continue fitting the remaining parts to the PC board. Conversely, if one or more of the regulator outputs is incorrect, switch off immediately and check for wiring errors. Most likely, you'll have made a mistake fitting D1 or D2, one of the electrolytic capacitors or one of the regulators. With a bit of luck, you'll be able to fix the problem and not have to replace any parts.

Completing the PC board

The remaining parts can now be fitted to the board, starting with the MKT audio coupling capacitors, the 2.2µF tantalum bypass capacitors and the 10µF electrolytic capacitors. The two ICs can then be installed, taking care that you fit each one the correct way around.

Note that the pins for IC2 (the LM833) are only soldered to the copper pads underneath, while some of the pins for IC1 (the MAX497) are soldered to the top copper pattern as well. This applies to pins 1, 3, 5, 7, 9, 11 & 13.

The next components to fit are the two 100nF bypass capacitors, which are at each end of IC1. These mount with their "earthy" leads soldered to the top copper pattern as well as the pads underneath. That done, fit the two remaining 100nF bypass capacitors for IC1 and the remaining 10µF electrolytic capacitor for the -5V rail. As before their leads are soldered to pads on the top of the board, with their "earthy" leads soldered to the bottom pads as well.

Final assembly

All that remains now is to fit the booster board to the case.

First, you have to fit the front and rear panels over their respective RCA connectors, before lowering the three items together into the bottom of the case. That done, LED1 can be pushed into its 3mm mating hole on the front

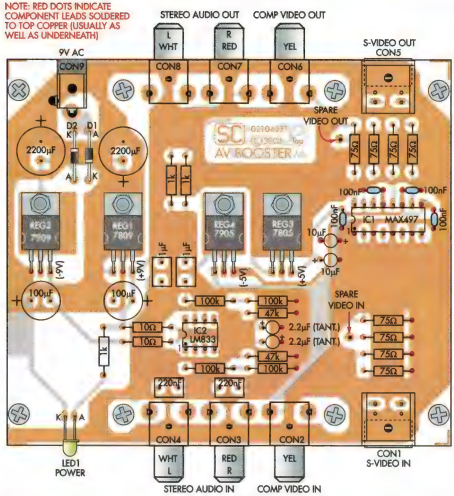


Fig.3: install the parts on the double-sided PC board as shown here. The red dots indicate where component leads must be soldered to the copper tracks on the top of the board (and usually underneath as well).

panel and the board secured to integral pillars in the bottom of the case using eight 6mm self-tapping screws.

Be sure to use all eight screws to secure the board. These give the board added support in the vicinity of the various input and output connectors.

The final step of all is to fit the top of the case, using the two long countersink-head self tappers provided. Don't lose these screws by the way, because they're a special size and surprisingly hard to get.

Your Video & Audio Booster is now be finished and ready for use.

Component video cables

Before we end up, let's take a look at the adaptor cables required if you want to use the booster for component video signals.

There's nothing terribly complicated about this. All you need to do is buy or make up four cables - two for the luminance (Y) signals and two for the chrominance (Cb and Cr) signals.

The cables for the Y signals each consist of single lengths of coax with an RCA plug at each end. These connect to the booster's composite video channel, as shown in Fig.1(c).

The other two cables are each of double coax, with a mini-DIN plug connected at one end and a pair of RCA plugs at the other. They are used to carry the Cb and Cr chrominance signals and are connected to the booster's S-video channels.

Note that both RCA-RCA and 2xRCA-miniDIN video cables are available from many suppliers. However, you may want to make up your own using high quality coaxial cable, to ensure lower signal degradation - especially if you have fairly long cable runs. Some prewired cables leave a bit to be desired in this respect.

By using the correct adaptor cables, the booster will operate just as effectively with component video as it does with composite video or S-video.

Happy home theatre viewing! SC

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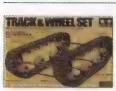

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3-Speed Crank Axle Gearbox Kit

This gearbox operates with three different gear ratios of 16:1, 58:1 and 203:1. Gear casing and gears are precisely moulded from durable plastic. Metal crank arms can be attached to the ends of the output shaft, creating versatility.

P 9049

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4-Speed Crank Axle Gearbox Kit

An altered combination of gears producing four different gear ratios of 126:1, 441:1, 1543:1 and 5402:1. These low output speeds are best suited when high torque is required as opposed to speed.

P 9046

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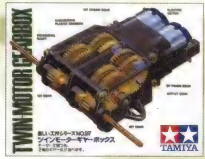

Twin Motor Gearbox Kit

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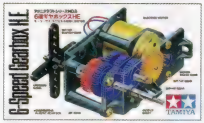

6-Speed Gearbox Kit

Six different gear ratios can be selected depending on the combination of gears. Gear ratios consist of 11.6:1, 29.8:1, 76.5:1, 196.7:1, 505.9:1 and 1300.9:1. Includes electric motor and three crank arms.

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Planetary Gearbox Kit

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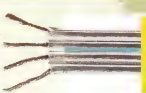

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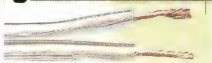

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The control circuitry can either be mounted remotely from the keypad (and connected to it via a cable) or plugged directly into the back of the keypad unit.

Tiny circuit uses a PIC & has lots of features

A highly flexible keypad alarm

This versatile little alarm can be used as a stand-alone alarm system for your home, commercial premises or car and also for keypad door entry. Or it can be incorporated into a larger main alarm system if required.

By JOHN CLARKE

Keypads are often used in security systems since they avoid having to use a key or remote control, both of which can be lost or copied. Keypads are widely used in commercial buildings to allow access through doors.

Here we are presenting a stand-alone keypad alarm system which, with the addition of a siren, a passive infrared detector and door switches, will provide a basic security system for the home, office, church or hall. Installed in a car, the keypad alarm can incorporate an engine immobiliser, as well as standard burglar alarm features.

To use the system, a number is entered in using the keypad. If the entered number is correct, the unit will respond accordingly and either arm or disarm itself and operate a door lock release, if connected. Exactly how the keypad alarm responds depends on the application and how the timer and options are set. For example, when used for keyless door entry, the unit needs to be always armed but operate the door lock release each time the correct code is entered.

Features

The list of features of this alarm is so extensive that it will take more space to briefly describe them all than to describe the circuit itself. That's because all the features are a result of the programming of the PIC microcontroller. Nevertheless, describe the features we must, so we will keep it as brief as possible.

For use as an alarm, the system needs to be armed on exit and disarmed on entry. Each application requires different operating characteristics and the alarm has a host of features which can be tailored to suit. External inputs and outputs include delayed and instant alarm inputs, and armed and alarm outputs.

The alarm output can only be activated by the inputs after the exit de-

lay. Instant and delayed inputs can be a passive infrared detector and door or window switches. Alternatively, the alarm can sound when the keypad is tampered with or if a duress code has been entered.

The tamper alarm is activated if more than five incorrect attempts are made within a 90-second period. The 3-digit duress code sounds the alarm when required. In each case, the alarm is deactivated by entering the correct code.

Three separate codes are available: Master, User and Service codes. All three codes can be different but must be of the same length. Either the Master or User code can be used to arm and disarm the alarm. The two different codes are included for use when several keypads are installed to operate door lock releases on separate doors. The Master code will gain access through all keypad operated doors, while the User code only allows entry to selected doors. These codes can be anywhere from 1-12 digits long. The last three digits of the user code become the Duress code.

The Service code is provided to change the codes, the various timers and options. The Service code itself can be changed and if a new Service code is entered, it also sets the length of the User and Master codes. If, for example, the Service code is six digits, then the User and Master codes must also be six digits. Generally, a 4-digit code is sufficient to provide adequate security. With four digits, the possible combinations are more than 14,000 (using digits 0-9 digits plus the * key.

If the entry or Service codes for the keypad are lost or a mistake is made on changing a code and the keypad becomes inoperable, there is a way to restore operation. This involves having several inputs tied to ground when power is applied to return to the default codes and settings.

Timers

The service mode also allows the various timing delays involved with keypad and alarm operation to be changed. All time periods can be set from 1-99s in 1-second increments. The delayed and instant input timers determine the time before the alarm is sounded after being activated. This delay gives time to enter the building and switch off the alarm before it sounds and is necessary if the keypad is mounted inside. The default settings are one second for the instant input and 10 seconds for the delayed input.

Similarly, the default for the exit delay (allowing you to leave the building after arming the alarm) is 15 seconds.

In addition, the instant input can be configured as an exit input – a switch

MAIN FEATURES

- 1 to 12-digit codes
- Separate Master and User codes
- Service code to alter codes and parameters
- Duress code to start alarm
- Instant and delay inputs
- Inputs triggered on change
- Optional easy exit input
- Exit delay
- Keypad tamper alarm
- Door lock output and indicator
- Armed output and indicator
- Alarm warning period
- Audible key entry acknowledge
- Key entry reset using #
- Keypad entry timeout
- All codes can be changed via keypad
- Adjustable timing parameters
- Alarm mode and keyless door entry options
- Default return facility for all codes, parameters and options
- Powers up in armed mode
- 12V operation @ 15mA (ancillaries extra)

This view shows how it all goes together. The 7-way SIL socket at the bottom of the PC board connects directly to a matching pin header on the back of the keypad.

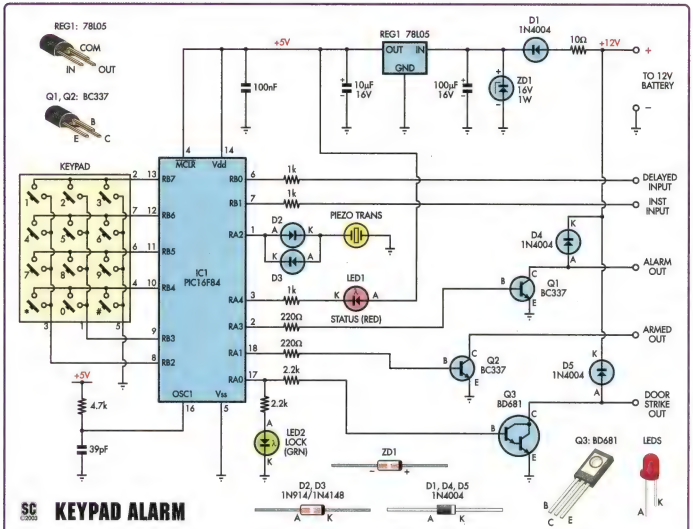


Fig.1: a PIC16F84 microcontroller (IC1) forms the heart of the circuit and is used to monitor the keypad and the delayed and instant inputs. It also controls the various outputs.

on this input will arm the keypad alarm instead of the user having to enter the code on the keypad.

A door timer sets the duration that power is applied to an electric door striker, to give sufficient time to open the door. The default value here is five seconds.

Yet another time sets the alarm duration (the default is 60 seconds). By the way, when we speak of a "default setting", it is the setting you get if you don't program in a setting.

There is also an "alarm warning timer". This sets the time period before a small piezo transducer in the keypad sounds and serves as a warning before the main alarm. The default is five seconds. Note that the alarm time starts at the beginning of the alarm warning period. Thus, the alarm warning period reduces the main alarm duration. There is no alarm warning if the keypad is tampered with or the duress code has been entered.

Finally, there is the keypad entry timer which sets the period during which the code must be entered. The default is five seconds but may need to be extended if the code is 12 digits long. If you make a mistake when entering the code, you can either press the hash (#) key to reset the timer or wait for it to time out before trying again.

If an incorrect code is entered but with the correct number of digits, the correct code can be immediately entered in again.

Arming options

Various options are also available to configure the following operations: arming, the door lock, the instant input and the armed output. For alarm installations, the unit must be armed and disarmed alternately, with each code entry. By contrast, keyless door applications will require that the unit be rearmed each time the code is entered.

Operation of the door lock will also depend on the application. For alarm use, for example, you may need to be able to arm the unit with the door lock activated – eg, so that you can exit the door when the keypad is mounted inside.

By contrast, an outside mounted keypad will need to operate the door lock on disarming, so that you can gain access. And in some cases, the door lock will need to operate on both arming and disarming. All of these options are available.

Operation of the armed output can

be altered as well. The default setting is with the output transistor conducting to ground when the unit is armed. When disarmed, the output can be pulled high with a resistor to the +12V supply.

Alternatively, you can have the output transistor conducting (to ground) when the unit is disarmed and open-circuit (pulled to +12V using a resistor) when armed. The armed output can control a main alarm unit or switch on an immobiliser in a car. It generally would not be used in keypad entry applications.

Status LEDs

The armed and door lock functions are both indicated with LEDs. First, the status LED (red) flashes once a second when the unit is armed and is off when the unit is unarmed. In alarm mode, this LED also flashes at a 2Hz rate to indicate the exit delay period, reverting to the 1Hz rate afterwards. In "service mode", however, the status LED is constantly lit.

The door lock LED (green) lights only while the electric door striker plate is powered. There is no alarm indication, except for the tone that occurs during the alarm warning period.

Circuit details

The circuit for the keypad alarm is shown in Fig.1. IC1, the PIC16F84 microcontroller, is the heart of the circuit and it is used to monitor the keypad and the delayed and instant inputs. It also controls the various outputs.

The keypad is a matrix of four rows by three columns. Two of the switch column connections go to outputs RB2 and RB3 respectively, while the third column connection goes to 0V (ground). The row connections are monitored by the RB4-RB7 inputs which are normally held at +5V via internal pullup resistors within IC1.

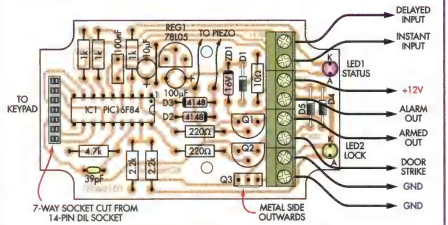


Fig.2: install the parts on the PC board as shown here. The PIC microcontroller (IC1) is installed in a socket and is left out of circuit until after the initial power supply checks have been made.

The delayed and instant inputs at RB0 and RB1 are normally held at +5V via internal pullup resistors. However, the micro can detect changes of state of either polarity, so if these inputs are held low by normally closed switches and they are opened, this can trigger the alarm condition.

False triggering is prevented in the following way. After the micro first detects a change in level at RB0 or RB1, it then checks again, after a short delay. If the voltage remains at the new level, the micro decides that this was a genuine change in level. Conversely, if the level is different after the delay, the program then decides the original change in level was a glitch or only a very momentary change and so is ignored.

The piezo transducer is driven via a square-wave signal at the RA2 output of IC1 to produce a tone. It is used to acknowledge each key entry and provide the alarm warning tone. Diodes D2 and D3 are included to prevent sound in the piezo transducer when the RA2 output is nominally low (ie, at 0V). What actually happens is that switching operations at other inputs or outputs can be reflected as very small voltage excursions above 0V and these would be heard in the transducer if the diodes were not included.

Outputs at RA3, RA1 and RA0 drive the alarm out, armed out and door strike transistors respectively. When RA3 is high, the base of Q1 is driven via the 220Ω resistor to switch on the transistor. The alarm out signal at the collector can sink a nominal 600mA maximum to drive a siren and flasher. Diode D4 protects Q1 against back-EMF spikes if the siren is an inductive load.

Transistor Q2 is driven via the 220Ω base resistor at the RA1 output. This transistor can also sink up to 600mA. It can be configured to switch on when armed and off when disarmed, or

Table 2: Capacitor Codes

Value	Old Code	EIA Code	IEC Code
100nF	0.1µF	100n	104
39pF	39pF	39p	39

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	3	1kΩ	brown black red brown	brown black black brown brown
❑	2	220Ω	red red brown brown	red red black black brown
❑	1	10Ω	brown black black brown	brown black black gold brown

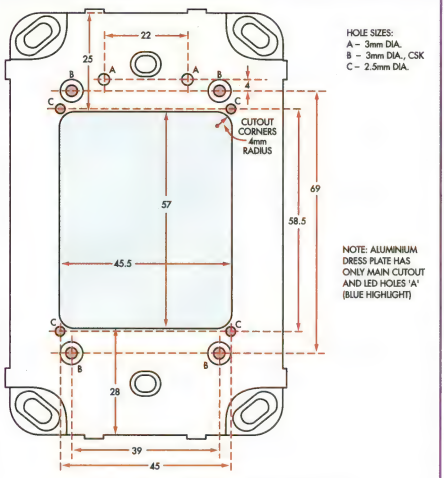


Fig.3: this diagram shows the cutout dimensions for mounting the keypad into a Clipsal blank plate. Make the cutout by drilling a series of holes around the inside perimeter first and then knocking out the centre piece.

switched off when armed and on when disarmed. If required, a pullup resistor can be connected between Q2's collector and the 12V supply.

Output RA0 drives Darlington transistor Q3 which is suitable for powering an electric door strike. This comprises a solenoid which releases the striker plate to allow a door to be opened. Diode D5 quenches the back-EMF caused by the inductive load of the solenoid when switched off. The transistor is set to sink a nominal 1.3A with the 2.2kΩ base resistor. Up to 4A can be handled if a 680Ω base resistor is fitted.

The door open operation is indicated with the Lock LED (LED2), driven from the same RA0 output.

IC1 uses an RC oscillator as its reference to set the various timing functions within its program. The oscillator components are the 39pF capacitor and 4.7kΩ resistor at pin 16. It runs at about 2.7MHz.

Power for the circuit is provided from a 12V SLA (sealed lead acid) battery or car battery (when used in a car). The SLA battery is kept charged using a plugpack style SLA charger. Power is fed to the input of the regulator via a 10Ω resistor and diode D1. The diode provides polarity protection while the 10Ω resistor limits current when the 16V zener conducts due to voltage spikes in an automotive installation.

REG1 provides the 5V supply for IC1 while the 100µF and 10µF capacitors at the input and output filter the voltage and ensure stability of the regulator.

Construction

The keypad alarm is constructed on a PC board coded 03104031 and measuring 78 x 48mm. It is mounted behind a Clipsal blank plate and in a small plastic utility box. The keypad sits in a cutout in the blank plate. An aluminium dress plate is clipped over this to produce a professional finish.

As an alternative to one-piece construction, it could be built as two separate units with the keypad remote from the circuit box and connected with 7-way cable. The component wiring diagram is shown in Fig.2. We recommend the separate construction method if the keypad is to be installed outside a building, to prevent any tampering with the electronics.

Begin construction by checking the PC board for any shorts between tracks or any breaks in the copper pattern. Check also that the holes are drilled to suit the components. The corners of the PC board also need to be shaped to clear the integral pillars inside the plastic case.

Install the resistors and wire link first. Table 1 shows the resistor colour codes. Use your multimeter to check the resistor values as well. That done, install the diodes, taking care to install the zener in the correct place. Install and solder in the two PC stakes.

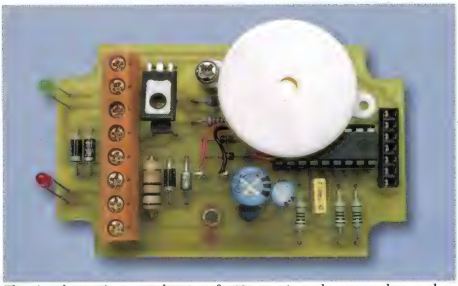
Q1 and Q2 are both mounted with the top of the transistor body 8mm above the PC board. Transistor Q3 mounts with its leads bent over at 90 and sitting on top Q1 and Q2. Q3 should have its metal face upwards.

Next, install the 5V regulator, the capacitors and IC socket. Take care to orient the socket and the electrolytic capacitors with the correct polarity. The keypad connection uses a 7-way socket cut from a 14-pin DIL IC socket. Cut the socket with a sharp utility knife to obtain the two socket strips. The second strip is soldered to the underside of the keypad.

The LEDs are soldered with their tops 21mm above the PC board. Finally, install the 8-way terminal strip.

Mounting the keypad

Mounting the keypad into the Clipsal blank plate is done by placing the keypad with the terminal end as close to the internal mounting hole bushing as possible. The cutout dimensions are shown in Fig.3. Mark out the required cutout for the keypad and cut this shape out by drilling a series of holes around the perimeter first and then knocking out the piece. File to shape afterwards. If you make



The piezo buzzer is mounted on top of a 10mm untapped spacer and secured using a 15mm machine screw and a 10mm tapped spacer which screws on from the underside of the board.

A brick wall may require the unit to be mounted onto a standoff box, such as the Clipsal No.449A shown here.

this cutout very neatly, it can be used as the template to cut out the front panel aluminium dress plate.

Four holes (marked C on Fig.3) are required for mounting the keypad. Use a 2.5mm (3/32-inch) drill. The holes to mount the plastic box directly beneath the plate are shown as B (countersunk). If you intend to mount the keypad and electronics separately, these four countersunk holes will not be required – see Fig.4 for the mounting details.

As shown in Fig.4, the PC board is secured in the plastic box using screws when installed directly behind the blank plate or clipped into the integral side clips of the box when mounted separately. The integral side clips will need to be snipped out with side cutters to a depth of about 10mm when the PC board is mounted directly behind the plate.

The keypad is connected to the PC board using the IC socket strips on both the keypad and PC board, with a 7-way pin header plugged in-between these. For the separate unit version, connection is via 7-way cable plus two extra wires for the piezo transducer.

The piezo transducer can be either mounted on top of a 10mm standoff for the single-unit installation or on

Parts List

1 PC board, code 03104031, 78 x 48mm
1 plastic utility box 83 x 54 x 30mm
1 blank plate and blank aluminium plate (Clipsal CLIC201VXBA or similar)
1 12-key numeric keypad (Jaycar SP-0770, Altronics S-5381 or similar)
1 8-way PC-mount screw terminal strip with 0.2" spacing
1 piezo transducer (DSE L-7022, Jaycar AB-3440 or similar)
1 14-pin DIL IC socket (cut for 2 x 7-way sockets)
1 18-pin DIP socket
1 7-way pin header 0.1" spacing
1 6mm spacer
1 10mm untapped spacer
1 10mm M3 tapped spacer
4 4G x 20mm self tapping countersink screws or M3 x 20mm csk screws
4 4G x 6mm self-tapping cheese-head screws or M3 x 6mm cheese-head screws
1 M3 x 25mm cheese-head screw
2 M3 x 15mm cheese-head screws
1 M3 nut
2 PC stakes
1 50mm length of 0.8mm tinned copper wire

Semiconductors

1 PIC16F84 programmed with Keypad.hex (IC1)
1 78L05 3-terminal regulator (REG1)
2 BC337 NPN transistors (Q1,Q2)
1 16V 1W zener diode (ZD1)
3 1N4004 diodes (D1,D4&D5)
2 1N914, 1N4148 diodes (D2,D3)
1 BD681 NPN Darlington transistor (Q3)
1 3mm red LED (LED1)
1 3mm green LED (LED2)

Capacitors

1 100µF 16V PC electrolytic
1 10µF 16V PC electrolytic
1 100nF MKT polyester
1 39pF ceramic

Resistors (0.25W 1%)

1 4.7kΩ
2 2.2kΩ
3 1kΩ
2 220Ω
1 10Ω

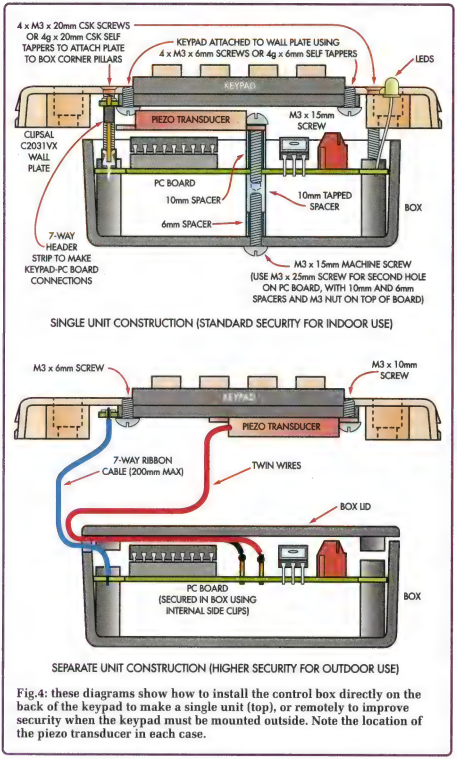


Fig.4: these diagrams show how to install the control box directly on the back of the keypad to make a single unit (top), or remotely to improve security when the keypad must be mounted outside. Note the location of the piezo transducer in each case.

the back of the keypad for separate units. The piezo transducer should be loud enough with the sound coming through the keypad itself. Extra holes can be drilled through the plate and aluminium cover if more sound level is required.

Testing

Connect power to the +12V and ground terminals and measure the voltage between pins 5 & 14 of the IC socket. This should be close to +5V. If correct, disconnect power and insert IC1.

Now reapply power with the keypad connected – the status (red) LED should be flashing at a one-second rate. Enter 1000 and the armed LED should extinguish. There should be a beep from the piezo transducer on each key press.

Enter 1000 again and the status LED should begin flashing twice per second and the green (door strike) LED should light for five seconds. After 15 seconds (the default exit delay), the status LED should return to the 1-second rate.

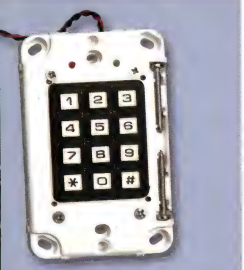
Enter in 2000 and the same results should be available as for the 1000 code. These are the default Master and User codes. Any mistake when entering a code can be cleared with the # key. Enter 000 for the duress code and the piezo transducer should sound for around one second and the alarm output should go low. This can be checked with your multimeter switched to a low Ohms range. To cancel the alarm output, re-enter the Master or User code.

Try entering more than six incorrect codes until the alarm output goes low again. Entering a correct code will stop the alarm.

Now enter the Service code – 3000. The status LED should now light continuously. Press # to cancel.

The Service mode allows changes to be made to the codes, delays and options. These are summarised in the Table 3. Changing the Master and User codes is done by entering the Service code, then a 1 for the Master code or a 2 for the User code.

Enter a new number code (maxi-



The keypad is secured to the wall-plate using four M3 x 20mm CSK screws. The modified aluminium dress cover then clips over the top to give a neat finish.

mum 12 digits). The * key can be used as part of the code. The # key exits and returns the unit to normal operation. The new code will be stored and can then be used. Changing the code again will require the same steps.

Note that the code entry length is set by the Service code and initially, with this being set at 3000, the Master and User codes can only be four digits long too. Also note that the 10th, 11th and 12th digits of the User code will set the duress alarm code if entered first. So be sure that any User, Master or Service codes do not start with these numbers, otherwise the duress alarm will sound.

Changing the service code

This can be done by entering the current Service code, pressing key 3 and then entering the new code. Pressing 12 keys will set all codes to 12 digits. Pressing only a few keys and then the # key will set the code at the entered length.

Note that the Master and User codes have defaults of 100000000000 and 200000000000 respectively (12 digits) and these are normally truncated to 1000 and 2000 when the code is four digits long. So if the Service code is increased in digits, then more zeroes will need to be entered for the default Master and User codes.

If you forget the Service code, it is possible to redeem the situation. First,

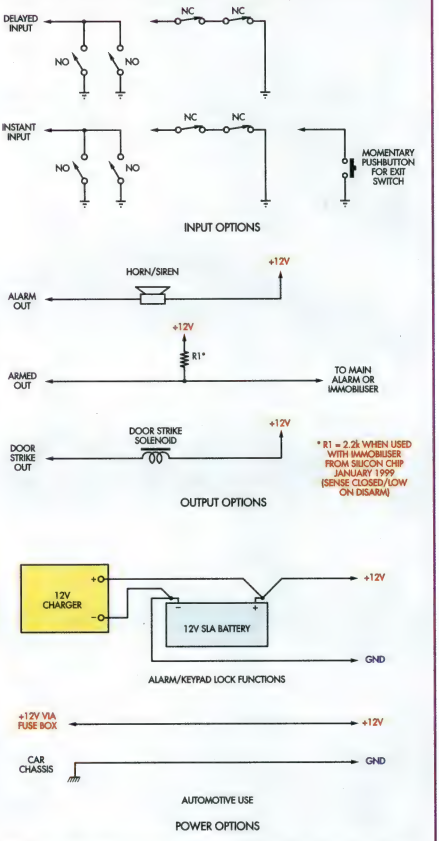


Fig.5: the input, output and power options for the keypad unit. Both the delayed and instant inputs can be connected to either normally open (NO) or normally closed (NC) switches but do not mix these two switch types on the same input.

TABLE 3: PROGRAMMING THE ALARM KEYPAD

For all service operations, enter the Service code, press the designated function key and then enter the code or value. Press the # key to end each single digit entry.

Key	Codes	Range	Default
1	Master Code	0-9 and * (1-12 digits)	1000
2	User Code	0-9 and * (1-12 digits) Duress Code is last three digits of 12-digit code	2000 (User Code) 000 (Duress Code)
3	Service Code	0-9 and * (1-12 digits) - sets code length	3000

Note: for codes less than 12 digits or timer numbers less than 10 digits, press # to enter value. Do not make the first three digits the same as the Duress Code.

Key	Timers	Range (seconds)	Default (seconds)
4	Delayed Input	1-99	10
5	Instant Input	1-99	1
6	Door Lock	1-99	5
7	Exit Delay	1-99	15
8	Alarm	1-99	60
9	Alarm Warning	1-99	5
0	Keypad Entry	1-99	5

Enter Service Code & Press *	Option	Mode	Default
	0# (16)	Alarm mode, lock powered on arming, instant alarm input	0
	2# (18)	Alarm mode, lock powered on arming, exit input	0
	4# (20)	Alarm mode, lock powered on disarming, instant alarm input	0
	6# (22)	Alarm mode, lock powered on arming, exit input	0
	8# (24)	Alarm mode, lock powered on both arming and disarming, instant alarm input	0
	10 (26)	Alarm mode, lock powered on both arming and disarming, exit input	0
	1#	Keyless entry mode, lock powered on rearming, instant alarm input	0
	3#	Keyless entry mode, lock powered on rearming, exit input	0

Note: entering the first option number means that the armed output is pulled to ground when the alarm is armed. Conversely, entering a bracketed number means that the armed output is pulled to ground when the alarm is disarmed.

Resetting To Default Values	
Tie instant & delay inputs low, hold down the 3 6 9 and # keys, and power up.	Resets all codes, timing parameters & options to default values.

switch off the power and tie the instant and delayed inputs to ground. Now hold down the 3, 6, 9 and # keys simultaneously and re-apply power. The status LED will light and stay lit until power is again disconnected. All codes and settings will then be set to their default values.

The delay values can be altered using keys 0 and 4-9, after entering the Service code. The delays can be set to any time from 1-99 seconds. Entry of a single digit time period needs to be ended with #, to store the value and exit the Service mode. Entry of a 2-digit value will automatically store and exit the service mode.

Suitable Accessories

Sirens: 12VDC at 500mA max - Altronics S-6127, S-6120, S-6125; Jaycar LA-5254, LA-8908, LA-5258, LA-5256; Dick Smith Electronics L-7031, L-7025, L-7029.

Siren strobe: Jaycar LA-5308.

Battery charger: 12V SLA 1.2 to 7Ah - Altronics M-8520; Jaycar MB-3517.

Security door latch: 12V DC - DSE L-5809; Altronics S-5385; Jaycar LA-5078.

Options

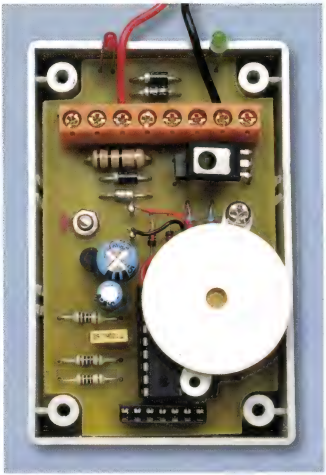
The options are entered in a slightly different way in that the * key is entered after the service code and then a number which matches the required operation mode is entered. The main change that can be made to the unit is from alarm operation to keypad entry mode operation. Alarm mode means that the unit is armed on entry of the Master or User code and disarmed on the second entry of the code. You can also select whether the door striker is operated on arming, disarming or both.

Input wiring

Fig.5 shows the connections that can be made to the keypad alarm. The delayed and instant alarms can be connected to normally open (NO) or normally closed (NC) switches. NO switches can be connected in parallel while NC switches are connected in series. It is not possible to mix NO and NC switches on the same input.

The switches can be set up in a doorway to detect opening or can be a part of an ancillary component such as a passive infrared detector. You can also use doormat switches, window switches and glass breakage tape, or similar.

Power options for the keypad unit are also shown in Fig.5. For automotive applications, it is simply connected between chassis for the ground supply and to +12V via the fusebox for the positive supply. The supply must be continuous 12V and not the switched supply used for ignition or accessories.



The PC board fits neatly into a standard plastic case, as shown here. The SIL socket at the bottom mates with a matching header on the keypad.

For other applications, the unit needs a 12V SLA battery rated from 1.2 to 7Ah capacity. 1.2Ah should be adequate for most applications but heavy usage of the door strike may require a larger battery.

Installation

This really depends on your application. For most installations, the keypad will be installed on a wall near the exit door. A brick wall may require the unit to be mounted onto a standoff box such as the Clipsal No.449A – see photo. **SC**

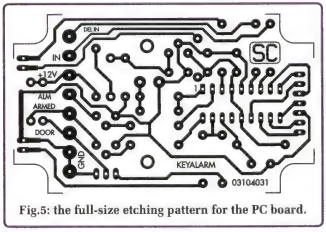


Fig.5: the full-size etching pattern for the PC board.

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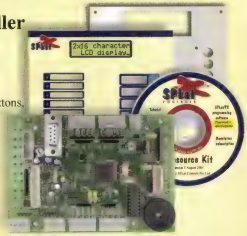

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SERVICEMAN'S LOG

So what if it's ancient technology?

I am still happily surprised at the amount of ancient technology that is brought to my door to repair. Most of it is probably not worth fixing but I am happy to oblige, where I can, if the client insists and is prepared to pay the cost.

Recently, I had a 1977 Sony KV-9000UB 22cm (9-inch) portable TV in for repair. I really couldn't believe anyone would want to fix such an old set but it had sentimental value for its owners. They were complaining of a seized UHF tuner and so were unable to get anything on the UHF bands.

Fortunately, access to the rotary tuner was easy and after removing its cover spring, I was able to get right inside it. The bearings of the variable capacitor had seized and the resulting strain (from trying to turn it) had broken the solder joints to the mounting plates. A hot iron soon fixed this and the bearings were freed with CRC.

Now the tuner could pick up channels easily. I then had to modify the UK specification sound system to the Australian system. This meant replacing ceramic filter CF201 to convert the 6.0MHz IF to 5.5MHz. I then had to tune T213 and T211 until the sound was loud and clear and the colour was free from herringbone patterning.

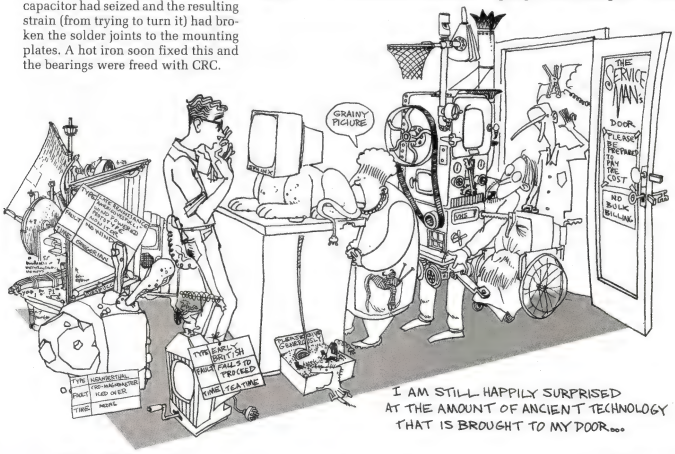
When I'd finished, I was amazed at how a vintage TV a quarter of a century old could give such a good sound and picture with such a basic circuit. One wonders how long all the new technology will last?

Philips VCRs

I've had a number of Philips and JVC VCRs in for repair. These include the Philips VR 250, 350, 450 & 550 series and the JVC HR-J240 series, etc. Philips uses the same JVC mecha-deck (PMC 0011A) in their models and they no longer service them. Instead, they offer exchange units and long warranties.

One common problem that develops in the 1994-1997 range of models is that the VCR is unable to eject the tape. Discovering the cause and fixing this the first time around was long and arduous but now I am quite adept at this repair.

What happens is that the tension spring to the change arm assembly



Items Covered This Month

- Sony KV9000UB TV set.
- Sony SLV-EZ7AS VCR.
- Samsung SV-641 VCR.
- Philips VR 250, 350, 450, 550 series and JVC HR-J240 series TV sets.
- 1993 Mitsubishi Diva CT-29ATS(A)TX TV set.
- NEC FS-59T90 TV set.
- Philips 29PT2255/79R TV set (L01.1A chassis).
- Philips 29PT4873/79R TV set (L9.1A chassis).
- Akai CT2007A TV set.
- Yamaha VR-5000 100W guitar amplifier.

comes off because the support bracket clip breaks on the latter. The part numbers are 4822 403 71304 (Philips) and PQ46353A-2 (JVC). You have to remove the whole deck and the cassette ejector cage assembly first before you can get access to it. You then have to remove the slide plate assembly.

That done, you can remove the change arm and swap the change gear onto the new one. Care needs to be taken refitting the spring as the new change arm doesn't look any different from the old one and will probably break again in exactly the same spot in a few years time (you would have thought they would have improved this assembly by now). Refitting the slide plate can be a bit fiddly but with gentle perseverance, it will soon all slip in with spring-loaded brakes (place in OFF position). Reassembling the rest is a breeze.

What can cause a lot of confusion is the tension spring from the take-up lever. The reason for this is that it isn't fitted on all models and yet the spring support clips are still there. This has been known to cause panic as you carefully comb the entrails of the VCR looking for the missing spring. My policy is that I haven't ever known this to break off, so if it's not there, it's not supposed to be there.

On the later JVC decks, (eg, HR-J457MS), I have also found that the drive gear axle (LP30243-001B) can sometimes break (this connects onto the cassette holder assembly).

I also had a Sony SLV-EZ7AS video (S-MECHA) with a right old mess inside, which I think can only be put down to forcing the mechanism. Anyway, the main cam and stopper, the slider and reverse brake arm were all smashed. The whole thing had to be stripped right down and reassembled and it was a good job I had the complete set of service manuals to do this.

Going crackers

A Samsung SV-641 hifi stereo VCR came in with the complaint that it was chewing tapes. This wasn't too surprising considering that I eventually retrieved a cheese cracker from within the mechanism – one to add to my collection of diamond engagement rings, false fingernails, cake, money, an ants' nest and, of course, the proverbial cockroach infestation.

When it came to testing the VCR, however, I discovered I couldn't tune it in on a TV set. In fact, it wasn't until I removed the antenna that I found the answer – it was slap bang on an SBS channel. The owner was unaware of this, as that SBS station was not available in his area but he did have a lot of patterning and interference on his VCR. Relocating it to Ch68 and using AV leads fixed this problem.

Faulty NEC

Mrs Jocelyn Gale, a charming old lady of 84, asked me to look at her 2-year old NEC FS-59T90 TV set (actually a Daewoo CP-785A) which had intermittent sound.

In deference to her age and her polite manner, I agreed to call round but I said there was a good chance it might have to go to the workshop, as it was intermittent. I told her to try giving the set a good belt when it played up and tell me about it before I called. In retrospect, this was bad advice, as osteoporosis may have done her more damage than the set.

Anyway, she told me this procedure hadn't broken her arm and did have an effect. I was delighted with this news because it was highly probable there was a crack or dry joint and I probably had a good chance of fixing it in her unit.

When I arrived, I noticed she was using headphones on the set, so as not to disturb her neighbours. Experience told me straight away that it was highly likely that the headphone jack socket had been damaged due to tension on the cord.

I removed the back and withdrew the chassis. It was soon apparent that my suspicions were spot on. I resoldered the PC-mounted socket (HP01) and also checked the audio output IC (IC602) and anything else that looked suspicious.

That fixed that problem but Jocelyn then wanted to try an infrared cordless headphone set to take the place of her wired headphones. I set them up for her and then spent some time patiently explaining that the receiver unit's batteries needed recharging when they weren't being used.

An old Panasonic

I had another 1991 Panasonic TC68A61 (M16M chassis) to attend to the other day. The owner complained of poor colour, which could mean anything.

When I got there, it was immediately obvious from the pink picture that there was no green. This fault can be caused by anything from the jungle IC to the picture tube. I started with the output transistors and measured the voltages around them and on the picture tube cathodes (M68KPH167X).

I was mostly comparing the voltages between the three colours and looking for differences, particularly on the green gun. Unfortunately, there was very little to pick, which really meant there was a problem with the tube itself. Just in case, I swapped the red and green transistors over and also tried using links to swap entire colour amplifiers over but to no avail.

The CRT analyser quickly showed

the problem. Unusually, it reported that the green gun had G2 open circuit and G1 to cathode short circuit.

Apart from changing the tube (which isn't cost effective), the only other option is to try to "boost" the tube by "blasting" the cathode with an AC voltage.

I did this and was extremely happy when the green came up immediately. I put the set on soak test but then, 10 minutes later, the picture (all colours) went very dull.

Over the next couple of days, I tried again and again to boost the tube and on each occasion I was successful for up to 10 minutes before it went dull again. Obviously, when the tube got sufficiently hot, the electrodes were touching again under the influence of gravity. In the end, there was nothing for it but to return the set to the owner and advise that it be scrapped.

Dead & ticking

A 1993 Mitsubishi Diva CT-29ATS(A)TX (ATMV691 chassis) was delivered to the workshop with the complaint that it was "dead and ticking". Its owner, Mr Plumley, thought it was the on/off power switch. Well, of course he would. I mean, there are only four components in a TV set, aren't there? – the fuse, the switch, the picture tube and its valve!

After all, what else would you expect for the money?

After spending half the morning undoing the 50,000 screws that held the back on, I finally managed to remove it. Next, just to satisfy my curiosity and Mr Plumley's conviction, I measured the on/off switch and the fuse. After all, they do occasionally fail. But not in this case – they were perfect.

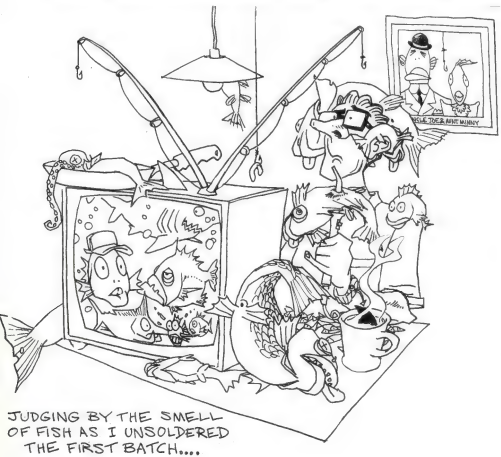
The power supply is a complex twin IC (master and slave) switchmode unit, designed to give good regulation of several rails in both manual and standby conditions. It also features full over-current, short-circuit and over and under-voltage protection.

So, where do you start? I measured full voltage going in and nothing coming out. There were no short circuits on the secondaries, only the usual load conditions.

I resoldered any likely dry joints but to no avail. Everything looked pretty good, so I diverted my attention to the electrolytic capacitors – and there were an awful lot of them.

There were two options here – I could either get all scientific and make lots of measurements to try to track down the faulty capacitor, or I could simply adopt a blanket approach and change them in batches. I opted for the latter.

Judging by the smell of fish as I unsoldered the first batch, I was immediately on the right track. After replacing just seven of them (C9B7, C9C1, C9C2, C9E1, C9E5, C9E9 & C9F1), the set was working perfectly. I soak tested it for a week before returning it to Mr Plumley who didn't know what a capacitor was. However, he did understand a 90-day warranty – I do hope the switch lasts that long!



Philips L01.1A chassis

I am beginning to see a few late-model 29PT2255/79R and 29PT2252/79R Philips TVs. I am talking about the L01.1A chassis, which came onto the market about 2001 onwards. The usual problem is that the set is dead due to the fact that the switchmode power supply is cactus.

The cause is not yet fully understood but this fault normally occurs during power surges. To fix it, I order and install what I call "Fred's Mod Kit", named after a friend of mine who repairs these sets under warranty. He found that eight parts usually need replacing – the chopper transistor (7521), its driver (7522), IC7520, R3523, R3530, D6523, D6524 and possibly D6525, which is not always fitted.

Of course, strictly speaking, this isn't a modification kit but only a replacement parts list. Perhaps a modification will come out in due course?

Another problem that is occurring is hum in some Philips models. One in particular comes to mind, the model 29PT4873/79R (L9.1A chassis), which can get particularly bad if placed on a resonating wooden table.

The cause is a deflection yoke with vibrating windings and the solution is to remove it and dunk it in Estapol varnish. Beforehand, it is a good idea to mask any areas that might be critical such as where it contacts the pic-

QLD ELECTRONIC REPAIRERS GOING ..... GOING ..... *GONE!!*

The new Electrical Safety Act will affect YOUR income!

If you previously thought this new law did not apply to you please be very careful because it most likely does! You may hold a restricted electrical licence but this is no longer enough in Queensland. There are several repairers that have closed already because of this law.

Before this law was enacted it is claimed that there was widespread consultation. Electronics repairers were not consulted and indeed at the meetings that were held far and wide only electricians turned up. This is not surprising because electronics technicians were never invited! Even more interesting is that electronic products such as TVs, photocopiers, pinball machines, sewing machines, marine electronics, computers and every other item repaired by electronics technicians **were never even mentioned** at these meetings!

The fine print of this new law means that a very large percentage of electronic repairers (who are not electricians) cannot obtain this licence even if they want to spend more than $1000 per year to comply. Electrical safety will not improve because of this law.

When the ESO inspectors call, and they will call, if you are found to be operating without a current Electrical Contractors Licence you can be fined up to 500 penalty units; that translates to $35,500 (for an individual) or $187,500 for a corporation or **SIX MONTHS JAIL!**

AETA is a newly formed "not for profit" association legally incorporated in Queensland with the aim of fighting for a better outcome from this bad legislation. We are technicians from all areas of electronics who are demanding fair treatment. AETA (All Electronic Technicians Association) will fight to have this ridiculous law amended and we urge you to join forces with us to sensibly oppose this new impost on your livelihood.

You cannot ignore this, it will not go away. It is now law, you must do something.

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ture tube and the three rubber spacers.

The procedure should be repeated three times, allowing it to dry after each dunking before reassembling it onto the tube neck. That should stop the windings from vibrating and fix the problem once and for all.

Kong Wah TV sets

I see a lot of the Kong Wah or similar Chinese-manufactured TV sets made for Teac, Akai and others. Most problems stem from electrolytic capacitors, particularly those located near heatsinks and other heat sources.

The other day, I had a slight variation on this theme that caused me to lose even more hair. It was an Akai CT2007A and it was dead. To begin with, I replaced the main culprits – ie, C911 and C909 (47µF). That done, I got stuck into the collateral damage, namely R917 and R421 (0.68Ω), plus 12V zener diode ZD401.

I now had sound and picture but unfortunately the picture was really crook! I connected a colour bar generator to the TV to try and make sense of it all. This resulted in large vertical black bars, a floating picture (intermittent horizontal sync) and colour reversal on every alternate bar.

All in all, it looked like a titanic failure of the jungle IC (IC301, AN5601K) – ie, a general flooding in all major compartments! However, before ordering, paying for and replacing this 42-pin high-density IC, I thought I would first check out some of the voltages and waveforms being fed into it.

This turned out to be a good move, because I measured just 3.2V on pin 10 (the 5.2V Vcc pin). This voltage didn't improve even after I had desoldered the IC pin. Following it back, I discovered ZD301 (a 5.1V zener) and R357 (270Ω 1W) coming from the +12V line. The latter was getting hot and it was fairly obvious that the zener was more than half dead.

Replacing it fixed all the symptoms and restored a healthy picture.

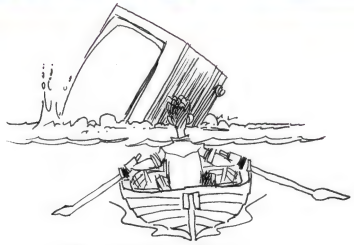
And now, here is a contribution from one of our readers. It comes from A. P. of Kuranda, Qld. Here's how he tells it . . .

Yamaha guitar amplifier

I recently started to do repairs for the local music store. So far I have had a steady stream of faulty cables, crackling volume control pots, faulty phone sockets and the like. Occasionally a more juicy morsel turns up.

The Yamaha VR-5000 100W guitar amplifier came with a brief note saying that the "power board" had "blown up". This amplifier has two fuses accessible from the rear panel. There is a 1.6A fuse which is in-circuit when the unit is set to run on 240VAC, plus a second fuse, rated at 3.15A, which is always in circuit and protects the unit when it is run on 110VAC.

In this case both fuses were intact but the 1.6A fuseholder held a 3.15A fuse. When I removed the amplifier from its case, it was clear that this overrated fuse had permitted extensive damage to occur. There were two charred areas on the PC board where 1/8W resistors had formerly resided



and it was clear that a couple of 0.22Ω 2W resistors had also overheated.

I tested all the components in the power amplifier section and made an inventory. The damaged parts were the two 2SC3181 NPN output transistors (Q711 & Q713); their 0.22Ω 2W emitter resistors (R717 & R719); a 2SC1980 transistor (Q652) in the speaker protection circuitry; two 150Ω 1/8W resistors (R655 & R656), connected between the base of Q652 and the emitters of Q711 and Q713 respectively; and two 100Ω 1/8W resistors (R741 & R742), spanning the emitters of the driver transistors.

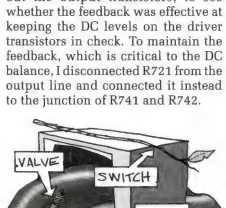
So what had caused the failure? Everything pointed to PNP driver transistor Q709 (2SC3421) but this tested OK. In the end, I shrugged my shoulders, replaced the damaged parts and repaired any PC-board tracks that had been damaged by the heat. But I hedged my bets a little and installed only one set of output transistors.

When I picked up the mains plug to insert it into the wall socket, I noticed that it wasn't the original OEM plug and that the neutral and active wires had been transposed. I made a mental note to correct this before returning the amplifier to the customer but left it as it was for the time being. Why? The active line visits both fuses and the connections are not in any way protected against accidental contact. It would actually be safer for me while I worked on the amplifier if all these connections were at neutral potential.

The switch-on was an anticlimax – there was absolutely nothing. The supply rails were showing 0V and I traced the problem back to the transformer. The 150°C thermal fuse in the transformer primary was open circuit. I couldn't easily get at it but there was electrical access to both sides, so in the interests of getting things going, I simply bridged it for the time being.

This time, when I switched on, there was again no apparent activity. However, when I checked the 1.6A fuse afterwards it had blown and so had the replacements for Q711 and its emitter resistor. So there was still a fault somewhere but at least I had demonstrated that the correct fuse protects most of the circuitry.

I decided to try the amplifier without the output transistors, to see whether the feedback was effective at keeping the DC levels on the driver transistors in check. To maintain the feedback, which is critical to the DC balance, I disconnected R721 from the output line and connected it instead to the junction of R741 and R742.



At the next switch on, I was immediately greeted by a stream of smoke coming from R741 and R742. I quickly switched off. Q709, the NPN driver transistor, was very hot but both it and the resistors seemed to have survived. Just to be sure that there wasn't a fault in Q709, I lifted one end of R713 (its base resistor) and switched on again. This time, Q709 remained cool.

Clearly, Q709 was being turned hard on. With R713 still out of circuit I measured the voltage at the junction of the two 100Ω emitter resistors. It was -44.9V. Perplexed, I checked the base voltage of Q710. It was -41.1V. – Q710 should be off.

And then the penny dropped: Q710 must have emitter-collector punch-through. I hadn't spotted it in my initial testing because I had only tested for diode action between base and emitter and between base and collector. Now wiser, I checked the collector-emitter resistance – it was a dead short in both directions.

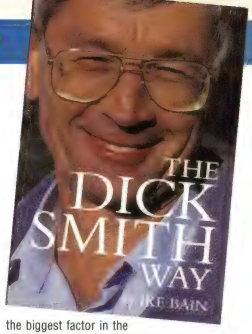
So Q710 was dragging the output very negative. Q709 was getting hot because it was driven hard on into a low resistance load. And Q709 was driven hard on by the fully functional first stages of the amplifier, which were desperately trying to correct that -44.9V output to match the 0V input.

Replacing Q710 brought everything back into line. I replaced Q709 too, just to be safe, since it had been seriously overheated.

I now considered what I should do about the power transformer, which no longer had its thermal fuse. I could easily fit a new thermal fuse but it would have to sit on the outside of the transformer where it might not respond quickly enough to prevent the wooden cabinet from catching fire.

This put me into an ethical dilemma. I didn't expect that the owner would be happy forking out $150 for a new transformer when the old one was working perfectly. But I also didn't want to return the amplifier in a state where it might cause a fire – even if that situation was precipitated by someone again replacing the 1.6A fuse by one with a higher rating.

Fortunately, when I contacted the owner he gave the go-ahead to replace the transformer. The replacement arrived in a few days. I fitted it, swapped the active and neutral connections in the mains plug and we were back in business. SC



THE DICK SMITH WAY, By Ike Bain. Published 2002, Mc-Graw Hill, Sydney. Soft covers, 135 x 207mm, 234 pages. ISBN 0074 71160 1 $22.95

When Dick Smith mentioned to me over a year ago that Ike Bain was writing a book about the old days at Dick Smith Electronics and Australian Geographic, I thought to myself, "This will be interesting!" I realised that Ike would have to be careful that he did not write a book which was simply a sentimental roam down memory lane.

At 234 pages, the book is not a long read. It is divided into two parts: Part 1 is entitled "Working With Dick Smith" (chapters 1-6) while Part 2 is "The Dick Smith Way" (chapters 7-16). These distinctions are in fact, quite arbitrary. Part 1 slides right through the book almost to the end.

Clearly, Ike loves Dick. Indeed, much of the book is a gushing hagiography. Dick is truly a remarkable Australian and it takes a book like this to make one realise that a quality biography on Dick is long overdue.

However, Ike unfortunately does not mention the most powerful factor in Dick's success, his wife Pip, until page 83. As I feared, Ike indulges in more than a little reminiscing. You could be forgiven for thinking that the book is also part autobiography. We learn about Ike's childhood in Canada and his decision to come to Australia.

We are regaled with stories about early days at DSE. If you took these stories at face value, you could reasonably conclude that Ike and Dick alone were responsible for the success of DSE. They were big factors but not the only ones. Ike was very good at managing retail operations but he is meanspirited in his praise of others. Very few names are mentioned in passing and none are given much credit. Worse, many hard-working and talented people have been omitted entirely. The people who established the hugely successful business operations in New Zealand were not mentioned at all.

On too many occasions Ike simply gets the facts wrong. For example, Ike claims on page 67 that Dick Smith picked the then future trend of CB radio. In fact, being a radio amateur, Dick was against CB radio at first, even though he may have been aware of the well-known popularity of CB radio in the USA. In those days, much of the 27MHz band was allocated in Australia to amateurs as the 11-metre band. But while the amateurs considered it a 'trashy' part of the spectrum, they weren't about to give it up to a bunch of non-technical yahoos who did not hold a licence. So Dick was justifiably concerned that lending his name to a proposal to establish an American-style CB radio system would diminish his standing in the amateur radio fraternity.

I was not an amateur and had no such qualms. At first, I was the guy doing the TV interviews and the press interviews. We were quickly so successful in selling CB radios that Dick relented and decided to become the voice of CB for the company. That was how Dick got the handle "Tricky Dicky," not as Ike claims in the book on page 66.

On page 119, Ike claims that DSE had "no money for marketing". This is simply not true. In fact, at that stage the company was spending hundreds of thousands of dollars on catalogs, brochures, advertising, etc. On pages 50-51, Ike suggests in June 1987 that it was he who was first to suggest that Australian Geographic should sell goods by mail order. On page 72 however, Ike reprints a letter from Dick to him a year earlier suggesting to Ike the very same thing. There are many other factual errors, some minor but still annoying.

Perhaps to some this criticism may sound rather pedantic. There is a point to it, however. On pages 79-80 he quite rightly tells us about the "paranoia" of avoiding errors by exhaustive means when he worked at AG. It's a pity that that lesson was lost on him in this book.

To be fair, most of Ike's recollections are sound. I distinctly recall the refreshing openness at DSE (page 147). I also appreciated Ike's retelling of those legendary stories about the April Fool's day fake iceberg, the Antarctic trips, etc.

However, if you did not know better, after reading this book you would think that Ike was there every step of the way, deeply involved in setting up importing operations, reviewing new products (pre-video), establishing the dealer network, closely working on the catalogs, coming up with marketing ideas (the big flag was his), keeping an eye on slow-moving stock, product costing, working with the electronics magazines on new project kits, etc.

In fact, I don't recall Ike doing much of this at all, certainly not during the 1970s, anyway. I mainly remember Ike flat out running the existing shops and opening new ones (and doing a good job at it, as well).

The things mentioned above were part of the 'engine room' of the DSE business. It took a second reading of the book to realise that Ike clearly missed a lot of the experience derived from this period. I say this because Ike neglects to mention possibly the biggest factor in the incredible profitability of DSE – that goods were directly imported from overseas and retailed without a local wholesale middleman. This was quite rare at the time.

This inexperience shows at the very end of the book as well. Ike's rather quaint and folksy business 'wisdom' grates. On pages 153-154 he tells us to "give away as little of your position as possible" when negotiating, and to be "tough" when negotiating with landlords. Unbelievable. He also tells us to hire "miserly" accountants on page 166. The fact is, accountants are there for other reasons. It is usually up to middle/upper management to keep an eye on costs. By the time the bill comes to accounts, the transaction is complete.

On page 159, Ike instructs us to trust no-one. This is not only ridiculous, it's sad. You simply cannot do everything yourself. You have to learn to trust people and 99% of the time if you are prudent with your choices of employee, you will be fine.

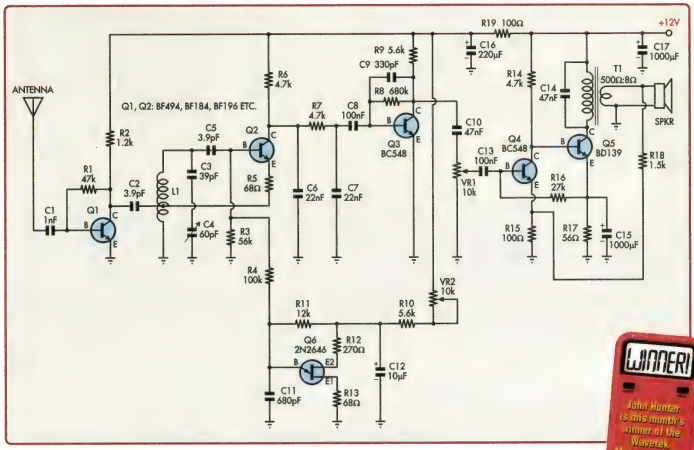
There are also a couple of mysterious omissions in the book: what happened to Dick Smith USA, or the reasons Woolworths would put DSE up for sale in 1986 if it was such a profitable company, irrespective of Woollie's problems elsewhere?

In the end, the book is a disappointment. The clumsy structure, confusion of purpose, factual errors, the omissions and the rather dated folksy wisdom add up to a fairly self-indulgent effort. However, it may be of some use to those who are interested in the corporate history of Dick Smith Electronics and Australian Geographic in the early days or as fodder for the corporate motivation junkie.

**Editorial note: Gary Johnston worked very closely with Dick Smith and Ike Bain for many years. In 1981, he left Dick Smith Electronics to buy John Carr & Co, which went on to become Jaycar Electronics.*

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Super-regenerative receiver for AM & FM

This little super-regenerative receiver is essentially an AM receiver, with "slope detection" used for FM. By tuning to one side of the carrier, the receiver's tuned circuit converts FM to AM. The bandwidth is about 200kHz so wideband FM stations can be demodulated by tuning the receiver to the most linear point of the response curve, rather than the top of the curve as one would for AM. In practice, this simply means tuning for clearest sound.

The heart of the receiver is Q2 which is a Hartley oscillator, with its tuned circuit in the base circuit. It determines the frequency of oscillation and hence the receiving frequency.

RF amplifier Q1 is a self-biased untuned common emitter amplifier stage, included to prevent aerial loading from affecting the detector's oscillation frequency and amplitude. It also reduces any RF radiated from the aerial. RF is coupled into the oscillator coil by C2. The aerial can be a piece of wire cut to 75cm. A 75cm telescopic rod aerial is better but a proper outdoor FM aerial is preferred for non-portable use.

Most simple super-regenerative detectors are self-quenched, however this makes it difficult to obtain the optimum quench waveform. Particularly for wideband FM, the quench waveform has a considerable effect on sound quality.

In this receiver, the quenching of the detector is achieved by Q6, a unijunction transistor (UJT) relaxation oscillator. The base of the UJT provides an approximate sawtooth waveform, which as it also provides the bias supply for Q2, takes the detector in and out of oscillation at about 50kHz.

It is necessary to be able to set the optimum quenching voltage and this is done by adjusting Q6's supply by trimpot VR2. This effectively functions as the regeneration control.

Present at the collector of Q2 is the demodulated AM or FM signal as well the supersonic quench. This is of sufficient amplitude to overload the following audio stages, so C6, R7, C7 and C9 provide simple low-pass filtering.

Transistors Q4 and Q5 form a class-A amplifier which can provide about 80mW output. Bias stabilisation is automatic using current feedback. If the current rises in Q5 then Q4 turns on harder, reducing the bias for Q5. Negative feedback is obtained from

the secondary of the speaker transformer and fed into Q4 via R18. The windings of the transformer must be phased correctly, otherwise the amplifier will oscillate. The transformer is a standard DSE/Jaycar 500Ω to 8Ω output type.

The prototype receiver uses the local oscillator section of a plastic AM radio tuning capacitor, in the same way as SILICON CHIP did with the TDA7000 FM receiver (November 1992 issue). (The aerial section tunes a ZN414 AM receiver in the same enclosure, sharing the same audio amp).

The air-cored coil (L1) consists of four turns of 18-gauge B&S tinned copper wire on a former with a 3/8-inch ID and tapped at one turn. With this coil, frequency coverage is about 60-150MHz depending on tuning capacitance.

As with all VHF circuitry, some care needs to be taken with construction. My portable version was built on a small piece of Veroboard. When using this, or any other super-regenerative receiver, it may often be found that an audible tone is heard in the background when listening to a station transmitting stereo or SCA programs. This is a result of subcarriers beating with the quench frequency. Adjustment of the quench frequency will usually minimise the problem.

In this receiver, if adjusting VR2 doesn't get rid of it, then it's worth experimenting with C11. It's important to note that raising the quench frequency too high will reduce receiver sensitivity. Decreasing the quench frequency will improve sensitivity but the subcarrier beat will be more evident.

Further decreasing it will make the quench audible at all times. For non-FM stereo/SCA applications, C11 can be increased until just before the quench becomes audible.

Optimum sensitivity occurs with VR2 adjusted to the point where the receiver has just gone into oscillation. At this point, a "rushing" noise becomes evident and stations can be tuned in. With very weak signals, it will become obvious that the settings of VR2 and C4 interact slightly. I tested this receiver with an HP 8654 signal generator and could receive a 3μV signal, albeit with some noise.

John Hunter,
St Leonards, NSW.

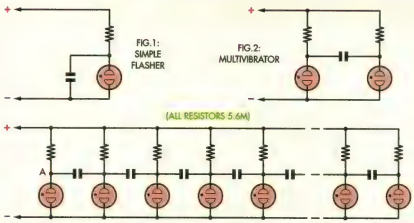


FIG.3: THE SCINTILLATOR

Neon scintillator with 300V up-converter

Years ago, small neon lamps were fairly common in electronics. You could make a simple relaxation oscillator flasher as shown in Fig.1 or an astable multivibrator as in Fig.2, or a multi-lamp flasher, the Scintillator, as in Fig.3.

If you connect the last lamp, through a capacitor, back to A, you get a ring counter in which the lamps turn on in sequence. If this connection is not made, you get a random flasher. With enough lamps and a not-too-fast sequence you get an eye-catching scintillating display.

Neons have the advantage for scintillation in that they flicker rather than glow with the unwinking stare of a LED. The trouble with neon circuits is that they need at least 100V to operate, though they take very little current.

Now you can get a 1.5V to about 300V up-converter for nothing! Just ask your 1-hour film processor to give you one of the used disposable cameras with a flash in it and you have all you need. **Warning: this is not a beginner's project because these cameras charge a capacitor to nearly 300V which could give you a lethal shock.** For others, the camera will already be partly open.

You should remove the outer case; it's just 'clicked' together. Take great care to keep away from the circuit board. On the board is a high grade electrolytic capacitor which can hold a charge for days and days. **Even if there's no battery in the camera, do not assume that the capacitor is dead.** As soon as you have clear access to the board, short circuit the capacitor until it is discharged. Remove the board completely from the camera. Mark on the board the polarity of the capacitor leads and then remove the capacitor. You now have a 1.5-to-300V up-converter of adequate rating to run your Scintillator.

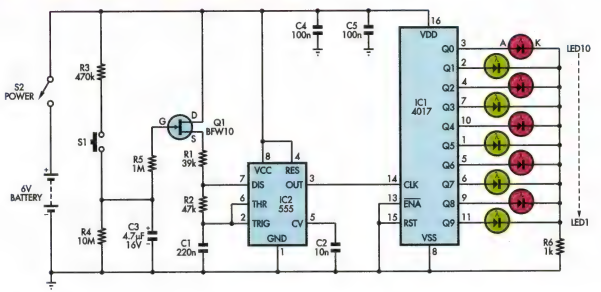
Next, find the press switch on the front of the board and short its contacts so that the board is energised as soon as a battery is connected. The battery contacts are not marked for polarity but a test with an AA cell will soon sort it out. One way works – the other doesn't!

Connect your Scintillator to the pads from which you removed the capacitor. The battery could be connected to its pads through a switch. The components can be mounted on a strip board in a jiffy box with the neons set out in wheel spoke fashion and viewed through some red perspex.

Neons are available from Dick Smith Electronics and Jaycar but if you want to save the cost, beg several dead cameras from the shop. Each has a neon lamp on its board, – the 'ready' light. These used cameras were thrown away in their early days but now they are recycled, so you may have to visit a few labs.

The current drain on the AA cell is fairly high so if you want a continuous display, feed it from a 9V DC plugpack and an LM317 regulator set to give 1.5V DC.

A. J. Lowe,
Bardon, Qld. ($35)



LED carnival game

This little game circuit has an interactive feature which combines a degree of control, chance and pretty lights. It was originally constructed as a gift for a procrastinating neighbour to elicit a decision by nominating different LED colours for "Yes" and "No".

The LEDs are arranged in a circle and the effect is similar to a roulette wheel except that in this case you get to determine how long and how fast you "spin" it.

At power up, only one LED is on. Pressing S1 causes the LEDs to light on and off in sequence, with the display running around the circle. The longer the switch is held down, the faster it runs.

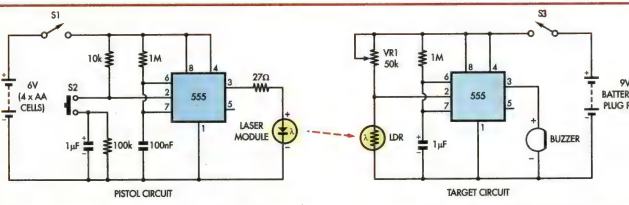
When the switch is released, the LED chaser slows down and comes to a stop in a random fashion.

The circuit consists of a 4017 decade counter (IC1) which is clocked by IC2, a 555 configured as an astable oscillator. JFET Q1 and resistor R1 provide the charging path to the astable oscillator. The drain-source resistance of Q1 is determined by its gate voltage which, in turn, is determined by the charge on capacitor C3.

Capacitor C3 is charged slowly via resistor R3 when pushbutton switch S1 is pressed. Fully charged, C3 will produce the lowest drain-source resistance in Q1 and hence, the fastest clock speed from IC2 to the "one-of-10" counter IC1.

When C3 is virtually discharged, Q1 is turned off and IC1 will not receive a clock signal, so it will stop with one LED lit.

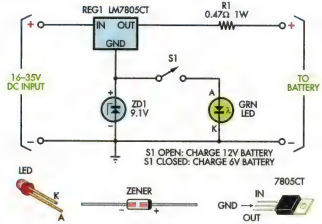
Filippo Quartararo, Tranmere, Tas. ($35)



Low cost pistol shooting game

This circuit uses just two 555 timer chips, one in the pistol and one in the target. The pistol circuit uses the 555 in monostable mode to pulse a laser module available from Jaycar Electronics (Cat ST-3115). The module has a small on/off switch which must be unsoldered and replaced with a wire jumper.

Switch S1 is the power switch (could be regarded as the safety)



Simple SLA battery charger

This circuit can be used to charge 6V and 12V sealed lead acid (SLA) batteries. The 3-terminal regulator REG1 is used to regulate the voltage and set the maximum charge current of 1A. It must be mounted on a heatsink.

When S1 is off, the charger is set to 12V mode which charges at a constant 13.8V. When S1 is closed, the charger is set to 6V mode and charges at a constant 6.9V.

When in 12V mode, the voltage across ZD1 is added to the voltage of the regulator. As the current through pin 2 of REG1 is so low, the zener diode voltage is lower than specified (ie, 9.1V nominal), so the total output voltage is around 13.8V.

When S1 is closed, the voltage across the LED (2.2V for a green LED) bypasses ZD1 and so the output voltage drops to around 6.9V.

Resistor R1 is included to protect REG1 from the sudden current spikes which would otherwise occur when the charger is first connected to the battery. This could destroy REG1 before its inbuilt current-limiting cuts in.

Car or motorbike batteries can be charged with this circuit although REG1 would have to be on a large heatsink (or fan-cooled), as it will be operating at 100% capacity for quite a few hours.

Philip Chugg,
Launceston, Tas. ($35)

while the trigger is S2, a momentary contact pushbutton. When pressed, it pulls pin 2 low via the uncharged 1µF capacitor and the output at pin 3 goes high for about 100 milliseconds for a short burst of light from the laser module. This short pulse stops any cheating. The trigger must be released before the pistol can be fired again.

The target uses a second 555, again in monostable mode. If the laser hits the light dependent resistor (LDR), pin 2 is pulled low and pin 3 goes high for about one second to sound the piezo buzzer.

Jack Holliday,
Nathan, Qld. ($40)

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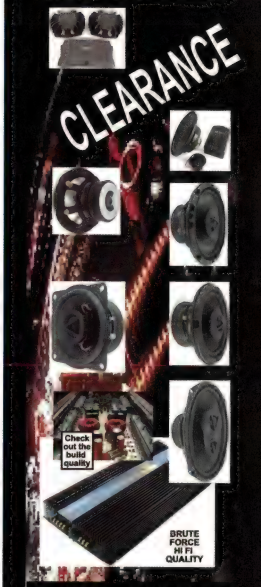
IMPORTER CLEARANCE



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A Telephone Dialler For Burglar Alarms

By LEON WILLIAMS

This project will dial a preprogrammed telephone number and send a warning tone via a modem when its input is triggered. Although primarily intended to connect to the output of an alarm system, it could be used for any purpose where you need to be notified immediately when an event has occurred.

IT'S A SAD FACT of life today that a great many homes are fitted with burglar alarms. Many of these alarms, especially low-cost self installed ones, don't have the facility to telephone the owner when an alarm occurs. If you were unfortunate enough to be away from home and have an unwanted visitor, you are dependent on someone making the effort to contact you, probably well past the time the incident occurred.

With this Alarm Dialler project connected to your alarm system, you will be notified within seconds of an alarm occurring, through a call to your telephone. And if you own a mobile telephone there's the added bonus that you can be virtually anywhere in the country and still receive the call. Once you are notified, you can then contact the authorities or a neighbour or friend for assistance.

As well as this obvious application, the project could also be used for other less critical uses; any time you want to be immediately informed that a particular event has happened.

The Alarm Dialler is an easy-to-build project using a PIC microcontroller and a handful of other inexpensive components, all housed in a small plastic box. The unit connects to a modem via a standard serial interface. It uses the modem to make and answer calls via your telephone line.

There are four alarm connection points on the rear panel, two for the alarm input and two that can be used to reset an external device. When in idle mode, it flashes a front panel LED and continually scans the alarm input connections.

If an alarm condition occurs, it sends commands to the modem to dial a preprogrammed telephone number. When you answer the call, you will hear a calling tone, and if the telephone has a calling identification display, you can also confirm that it

is your alarm system calling.

The Alarm Dialler has many options, allowing it to be used in a broad range of applications. The various alarm input configurations are selected with a multi-way DIP switch, while other settings such as stored telephone numbers are programmed using a PC and a simple menu system.

Why use a modem?

You may ask yourself, why do we need to use a modem? While it may seem an unnecessary complication, it does provide an easy solution to a number of design problems. First, it avoids us having to connect our device directly to the telephone line, as the modem provides the necessary safety isolation. Second, a modem provides all the functions we need to make and answer calls, which greatly simplifies the Alarm Dialler hardware circuit.

These functions include looping the line to establish and answer calls, dialling DTMF digits, ring detection, tone generation and connection timers.

The Alarm Dialler communicates with the modem via an RS232 interface. The speed is permanently set in the PIC at 2400bps and while this is slow by today's standards, it's fast enough for our needs and more importantly, eases the burden on the PIC software UART.

The modem requirements are very modest and so it only needs to be a basic type. More than likely you have an old modem lying around somewhere that can be put to service. If you don't, you can buy one second-hand or even a new one at a very reasonable price.

Basically, all modems are 'AT' compatible. This means that they communicate with a PC using the AT command set. The PC sends commands to the modem preceded with the letters AT meaning ATtention. The modem also sends messages to the PC on this interface.

The modem can be configured to talk to the PC using strings of letters (verbose) or single digits (terse). Single digit messages are generally used when a human is not viewing the responses and this is how the modem must be configured to work with the Alarm Dialler.

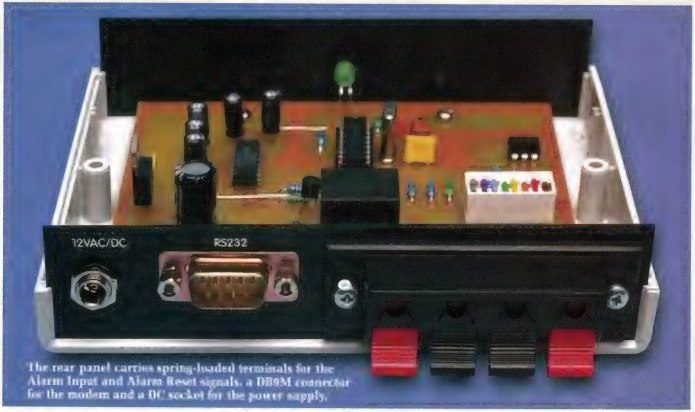
Alarm input options

The Alarm Dialler has a 2-wire connection point and can accept either a contact or switched voltage alarm system output (see Fig.1).

The contact output could be from a standard relay, a switch or perhaps a reed relay, using either normally open (N/O) or normally closed (N/C) contacts. When a contact input is used, the main board is electrically connected to the outside world. For this

Main Features

- PIC microcontroller based.
- Alarm input can monitor N/O or N/C contacts or an external voltage .
- Alarm reset output.
- No direct connection to the telephone line. Uses a standard modem to make and answer calls.
- Dial in and test if system operational.
- Programmed easily via a PC. Programmable retry attempts; Primary and Secondary telephone number store.
- Alarm input inhibit switch.
- Automatic alarm reset option.
- EEPROM stores settings in case of power outage.
- Uses low-power 12V AC or DC power supply.
- Cheap and easy to build.



The rear panel carries spring-loaded terminals for the Alarm Input and Alarm Reset signals, a DB9M connector for the modem and a DC socket for the power supply.

Table 1: Alarm Input Options							
Normal Condition	Alarm Condition	S1/1	S1/2	S1/3	S1/4	S1/5	S1/6
Open contacts	Closed contacts	On	Off	On	Off	On	Off
Closed contacts	Open contacts	On	Off	On	Off	On	On
Voltage Off	Voltage On	Off	On	Off	On	Off	Off
Voltage On	Voltage Off	Off	On	Off	On	Off	On

reason, it is important that the external alarm contacts do not have any voltage applied to them and that the cable to the Alarm Dialler is not too long. A very long cable could possibly get noise induced into it, which could lead to false alarms.

Alternatively, if using the external voltage option, the normal state can be either voltage "on" (up to 50V DC) or voltage "off". The normal state means that this is the condition when the alarm is not active.

With this type of input configuration, the Alarm Dialler circuit is electrically isolated from the alarm input by an optocoupler (OPTO1). Only a few mA of current is needed to operate the optocoupler and **this is achieved with around 4V on the alarm input terminals.**

If you want to use a much higher voltage than this, an external resistor should be placed in series with the input to limit the current through the optocoupler LED. Note that DIP switches typically have a maximum rating of 50V DC at 100mA.

The alarm input options are set with DIP switches 1-6 and Table 1 shows the settings for each option.

Alarm reset output

The Alarm Dialler provides a set of output relay contacts that operate for one second and can be used to reset the alarm or some other external device. The PC board has provision to connect either the N/O or N/C contacts for this purpose. The relay will only operate after three incoming calls have been received within 90s after an alarm has been detected or, if Automatic mode is selected, after all outgoing calls have been made.

Program menu items

The program menu is produced by the Alarm Dialler and displayed on the connected PC screen. Each menu item is described below.

Automatic mode: The Alarm Dialler has the option to be in either Automatic mode or non-Automatic mode. When Automatic mode is set to Yes, a non-interactive mode is selected. This is simply where the preprogrammed number or numbers are dialled with a 45-second delay in between calls. After all the calls have been made, the relay operates for one second. The Alarm Dialler will not return to scan mode until the non-alarm state is found. This prevents it from continually calling if the alarm is not reset.

When Automatic mode is set to No, the Alarm Dialler is in interactive mode and it is possible to reset the alarm without having to wait for all the calls to be dialled. During the 45-second wait period between outgoing calls, the Alarm Dialler monitors the modem for a ring message.

If an incoming call is detected during this 45-second inter-call period it then waits a further 90 seconds for two more. It is necessary to receive a total of three calls within the 90-second period to reset the alarm. If only a single incoming call was allowed to do this, a random call from someone else could accidentally reset the alarm before you were contacted.

If three calls are detected, it considers that you called in response to the alarm. It then resets the alarm, cancels all further calls and returns to scan mode.

If an incoming call is not detected or less than three are counted during the 90-second period, the next outgoing call is attempted, unless all the retries have been completed.

Primary number: This is a 19-digit store to hold the telephone number of the first number dialled after an alarm is detected.

Secondary number: This is a 19-digit store to hold the telephone number of the second number dialled after all the Primary number retries have been completed.

Use secondary: If this option is set to Yes, the Secondary number will be dialled after the Primary number is finished. If set to No, the Primary number is the only one dialled and the Secondary number is ignored. While this option is valid in Automatic mode, in general it will only be set to Yes in Non-Automatic mode. In this case, if a response to the Primary number calls is not received, the Secondary number will then be dialled.

Retries: This is the number of retry attempts allowed for each telephone number. The range is 1-9.

Full details of how to program the Alarm Dialler are covered later in this article.

Remote status checks

The Alarm Dialler incorporates extra features that allow you to remotely check its status.

If everything is normal and there are no alarms, the front panel LED will flash and incoming calls will be ignored. However, if there are three separate incoming calls within 90 seconds, the first two calls will be ignored but the third call will be answered. When the modem answers the call by going on-line, it sends an answer tone and then drops off-line after 20 seconds. By using this feature, you can tell if the unit is powered up and operating normally from anywhere that you can use a telephone.

The only indication the Alarm Dialler has of an incoming call is a ring message from the modem. The modem sends the digit "2" each time a burst of ring is received. The Alarm Dialler counts the time in seconds between ring bursts to distinguish between those within the same call and those from separate calls.

When an incoming call is being received from the telephone exchange, ring bursts are two seconds apart. However the time between the last ring burst from one call and the first ring burst from the next call will be much greater than this. The Alarm Dialler will register a new call if the gap is larger than six seconds.

It would be unusual to receive three calls within 90 seconds in normal use and so the unit should rarely answer a random call. Even if someone does call three times in quick succession, all that will happen is that the unit will answer on the third call send the answer tone and then drop off line again. Obviously, if you are unable to get the Alarm Dialler to answer at all, either the unit or the modem has failed,

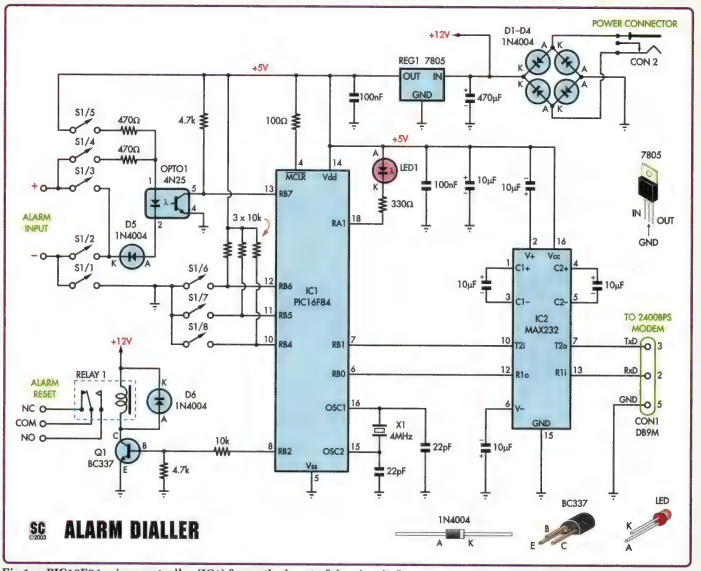


Fig.1: a PIC16F84 microcontroller (IC1) forms the heart of the circuit. It accepts the Alarm Input signal and drives an RS232 transceiver (IC2, MAX232) which interfaces to the modem. The modem, in turn, connects to the telephone line and carries out the dialling.

the power is off or the telephone line is faulty.

Failed call state

If an alarm has occurred and the Alarm Dialler has exhausted all its call retries and did not get an incoming three-call response, it goes into a failed-call state. In this mode, it will not return to normal scan mode until it has received three calls within 90 seconds.

This is done for two reasons. First, it avoids continually sensing an alarm condition and re-dialling if the alarm has not been reset. Second, it allows you to check if an alarm has occurred, if you have not been previously contacted.

While in failed-call mode, the Alarm Dialler will answer every incoming call. So if you call the unit to check its status and it answers immediately, this indicates that an alarm has almost certainly occurred.

To double check that this is the case, call again two more times, within the 90-second period. If the unit answers every call then an alarm has occurred. This three-call sequence will also reset the alarm and return the Alarm Dialler to scan mode. Note that this alarm checking and reset feature is only available in non-Automatic mode.

Receiving an alarm call

If the Alarm Dialler is programmed for Automatic mode, it will simply call the Primary and Secondary numbers, depending on the values set for 'Use secondary' and 'Retries'. It is not possible to call the Alarm Dialler during this process and cancel the calls. For this reason, it's probably a good idea to keep the 'Retries' number low and only use the Secondary number option if really necessary. Each time you answer the call, the modem calling tone will be heard for 20 seconds and then the call will be terminated.

In non-Automatic mode, it is possible to reset the alarm without having to wait for all the calls to be dialled. During the 45-second wait period between outgoing calls, the Alarm Dialler monitors the modem for a ring message. Note, however, that because the modem is online for 20 seconds after the call is made, there is only effectively 25 seconds for you to call the Alarm Dialler before the next call is made.

When you receive an alarm call you

Parts List

1 PC board, code 03204031, 115 x 99mm
1 plastic case, 140mm x 110mm x 35mm (Jaycar Cat. HB5970)
10 PC board stakes
1 8-way DIP switch (S1)
1 4MHz crystal (X1)
1 DC panel-mount socket
1 9-pin male 'D' connector with locking nuts
1 4-way speaker connector (Jaycar Cat. PT-3002 or equivalent)
1 12V SPDT relay (RLY1)
1 18-pin IC socket
2 10mm x 3mm screws and nuts
4 small self-tapping screws
Light duty hook-up wire, tinned copper wire

Semiconductors

1 PIC16F84-04P (IC1; programmed with ALARM.HEX)
1 MAX232 RS232 transceiver (IC2)
1 4N25 optocoupler (IC3)
1 BC337 NPN transistor (Q1)
6 1N4004 power diodes (D1-D6)
1 7805 positive 5V regulator (REG1)
1 5mm green LED (LED1)

Capacitors

1 470µF 25V PC electrolytic
5 10µF 16V PC electrolytic
2 100nF (0.1µF) MKT polyester
2 22pF ceramic

Resistors (0.5W, 1%)

4 10kΩ	1 330Ω
2 4.7kΩ	1 100Ω
2 470Ω	

will hear the modem calling tone and you must wait for the modem to time out and go off -line before calling back.

Circuit description

The full circuit for the Alarm Dialler is shown in Fig.1. As you can see, there's not a lot to the hardware because, as mentioned before, the line interfacing functions are handled by the modem.

The microcontroller used is a PIC16F84 (IC1) which does all the hard work. It has 1K of ROM (which is just about all used in this project), 68 bytes of user RAM and 64 bytes of non-volatile EEPROM. The EEPROM holds the configuration settings in case of power failure.

Pin 14 is the power supply pin, while ground (0V) is connected to pin 5. The reset input (pin 4) is held permanently high via a 100Ω resistor and this simple reset system has proved to be effective. The internal oscillator appears at pins 15 and 16 and a 4MHz crystal is used to supply accurate timing for the internal counters.

Pin 10 is connected to the Program switch (S1/8) with an external 10kΩ pull-up resistor, so that with the switch open, the pin is read as high or a one. When the switch is closed, the pin is read as low or a zero. Pin 11 is connected to the Inhibit switch (S1/7) and works in the same manner.

Pin 7 is the transmit data pin and is normally high, pulsing low when a zero data bit is sent. Pin 6 is the receive data pin and is used to both interrupt the PIC when a character is received and to receive the actual data bits.

Normally, pin 6 is high with no data present and goes low when a character start bit is received. This negative edge interrupts the PIC and forces it to enter the interrupt routine. This routine samples the eight character bits and stores them in an internal PIC register. After the stop bit has been received, it exits the interrupt routine and the main code processes the character.

More complex microcontrollers have a dedicated hardware UART to do this receiving but in this less-qualified PIC we must do this in software. The UART operates in half-duplex mode, meaning that it cannot send and receive data at the same time.

Pin 18 controls the LED and when it is low the LED is on and when it is high the LED is off. A 330Ω resistor limits the LED current to around 10mA.

Pin 8 is the relay output pin, which is normally low and goes high for one second to turn on transistor Q1. When the transistor is biased on, relay RLY1 operates, providing the reset signal to the alarm system.

Pin 13 is the alarm input pin. The normal state can be high or low, depending on the input switch settings. Switch S1/6 tells the PIC whether the voltage on the alarm pin is the normal or the alarm state. If S1/6 is off, pin 12 is held high and the alarm state is when pin 13 is low. If S1/6 is on, pin 12 is held low and the alarm state is when pin 13 is high.

IC2 is a MAX232 RS232 transceiver used to interface the 5V logic signals in and out of the PIC to the 9-pin interface. It only requires a 5V power supply and produces the required plus and minus RS232 voltages by an internal inverter using four external 10µF capacitors. IC2 has two receivers and two transmitters but only one receiver and transmitter are used in this circuit.

On the RS232 side, pin 13 is the receive data input and connects to pin 2 of the 'D' connector, while pin 7 is the transmit data output connecting to pin 3 of the 'D' connector. On the logic side, pin 12 is the receive data pin and pin 10 the transmit data pin.

A 4N25 optocoupler (IC3) is used to isolate the PIC from external voltages on the alarm input. When about 3mA of current flows in the internal LED, the transistor within IC3 is turned on. This takes pin 5 of IC3 low and consequently pin 13 of IC1 low.

When DIP switches S1/1, 3 and 5 are off and S1/2 and 4 are on, the input is configured to accept an external voltage input. The current through the optocoupler LED is limited by a 470Ω resistor and protected from reverse polarity by diode D5. In this configuration, the input circuit is completely isolated from the main PC board components. The external positive voltage must be connected to the "+" alarm point, otherwise diode D5 will be reversed-biased and the alarm will not be recognised.

When DIP switches S1/2 & 4 are off and S1/1, 3 & 5 are on, the input is configured to accept a contact input. In this mode there is no external voltage to operate the optocoupler LED, so the internal +5V rail is supplied through the same 470Ω limiting resistor and diode D5.

The power supply is a 3-terminal voltage regulator circuit providing 5V from a range of input voltages. A diode bridge comprising diodes D1-D4 allows both AC and DC supplies to be employed. If a DC supply is used, the positive lead will be directed to the regulator input, irrespective of the polarity of the power connector wiring.

The main reason for using this circuit is to allow a wide range of power supply possibilities. The Alarm Dial-

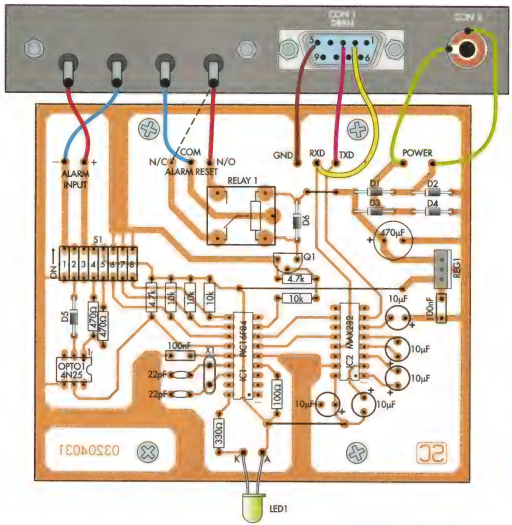


Fig.2: install the parts on the PC board as shown here, taking care to ensure that all polarised parts go in the right way around. The Alarm Reset output has only two connections, so select either the N/O or N/C contact, depending on your application (ie, use one or the other but not both).

ler draws minimal current – only about 50mA maximum when using a 12V DC supply.

Construction

Fig.2 shows the assembly details. Start construction by installing the parts on the PC board. There are three wire links to be installed, so do these first. Ensure they are straight and lay flat on the PC board. Follow these with the smaller components, such as the resistors, diodes and IC socket.

Next, install the capacitors, ensuring that the electrolytics are installed with correct polarity. The relay, DIP switch and PC stakes can be installed next. Follow this with the transistor, crystal and ICs, leaving the PIC chip till later.

The LED is installed with 15mm of lead length and then bent at right angles so that it can push out through the hole in the front panel when the PC board is secured in place. The 5V regulator (REG1) runs quite cool and won't need a heatsink under normal circumstances.

Once the PC board is loaded, you can prepare the case – see the photo-

Resistor Colour Codes

	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	4	10kΩ	brown black orange brown	brown black black red brown
❑	2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	2	470Ω	yellow violet brown brown	yellow violet black black brown
❑	1	330Ω	orange orange brown brown	orange orange black black brown
❑	1	100Ω	brown black brown brown	brown black black black brown

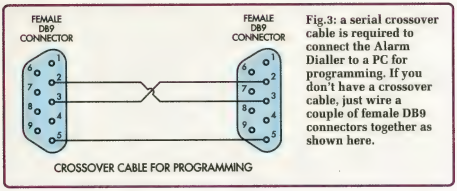


Fig.3: a serial crossover cable is required to connect the Alarm Dialler to a PC for programming. If you don't have a crossover cable, just wire a couple of female DB9 connectors together as shown here.

graphs as a guide. Start by drilling holes in the rear panel to mount the power socket, the alarm connector and 'D' connector – see Fig.6. The alarm connector used in the prototype is a 4-way speaker terminal strip and requires four holes for the connector tabs and two for the mounting holes.

Finally, drill a hole in the centre of the front panel just large enough to allow the LED to slide through.

Once the case has been prepared, install the power socket, the alarm connector with 3mm screws and nuts, and the 'D' connector with locking nuts. Mount the PC board in the case with four small self-tapping screws.

Slide the rear panel into place and then wire the rear panel connectors to the PC board stakes with light duty hook-up wire. The alarm input is polarised, so make sure that the red terminal is wired to the "+" alarm PC stake. The alarm reset output has only two connections, so select either the N/O or N/C contacts, depending on your application.

Note that because we are using a diode bridge at the supply input, you don't have to worry about the polarity of the supply wiring.

When all the wiring is completed push the LED back and slide the front panel into place. Now slide the LED into the hole in the front panel so that it pokes through by a few millimetres.

Initial testing

Once construction is complete, connect the power supply and, using your multimeter, measure the voltage at the power supply stakes on the PC board. The power supply can be anywhere between 12-20V DC or 9-16V AC without requiring a heatsink on the 5V regulator.

If you are going to operate the unit in areas of high temperature, then either a heatsink should be added to the regulator, or preferably, reduce the voltage of the power supply. Although the relay coil is rated for 12V operation, using a higher supply voltage shouldn't be a concern, because the relay is energised for only one second at a time.

Next, measure the voltage at the output of REG1. You should get a reading close to +5V and the same voltage should be at pin 14 of the PIC socket.

Pins 2 & 6 of IC2 will be a volt either way of +9V and -9V, respectively, if this IC is working correctly. If not, remove the power source quickly and look for errors, especially with the power wiring and the installation of the polarised components.

If everything looks OK, remove the power, wait a few seconds and insert the programmed PIC chip into the 18-pin socket. Apply power again and after a short period you should see the LED flash briefly and then repeat after a few seconds delay. Each time the LED flashes, it is sending AT to the modem and looking for an OK (0) response.

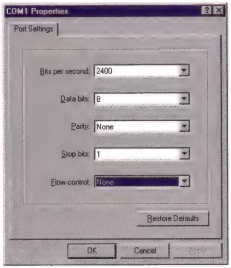
This is done each time the Alarm Dialler powers up and is used to ensure that the modem is connected and the interface is operating at the correct speed before normal alarm monitoring commences.

Alarm Dialler programming

Turn off the power to the Alarm Dialler and connect a PC running a terminal emulation program such as HyperTerminal using a serial crossover cable. The PC needs to be set to 2400bps, 8 data bits, no parity and 1 stop bit with flow control off (Fig4a).

Note that the Alarm Dialler's RS232 interface is similar to the one on your PC and to get them to talk to each other, you need to cross the data lines over. This means that the transmit data pin of the Alarm Dialler goes to the receive data pin of the PC and vice versa.

Fig.3 shows how to make a simple



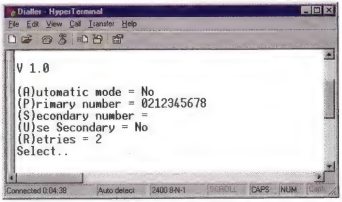
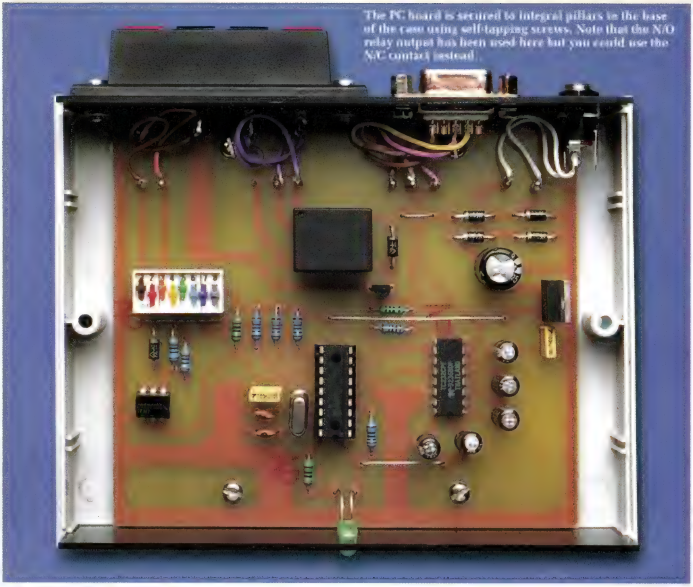


Fig.4a (left) shows how to set up the PC's COM port to communicate with the Alarm Dialler when you start HyperTerminal, while Fig.4b (above) shows the menu that appears in the HyperTerminal window when the Alarm Dialler is in programming mode.



The PC board is secured to integral pillars in the base of the case using self-tapping screws. Note that the N/O relay output has been used here but you could use the N/C contact instead.

crossover data cable, with a couple of 9-pin female 'D' connectors and three pieces of hook-up wire. Or you can buy one if you prefer.

Once connected, place S1/8 into the on position and apply power to the Alarm Dialler. Now move S1/8 to the off position, the LED should turn on and the menu appear on the PC screen. The menu is easy to understand and navigate and the items will be self-explanatory. **Simply select the desired option by pressing the character in brackets for that option and remember to use upper-case characters – see Fig.4b.**

Programming options are stored in the EEPROM as they are entered and there is no need to do a separate save action. If an out-of-range or illegal entry is made, an error message is displayed and the menu refreshed.

To exit the programming mode, place S1/8 into the on position again and then back to the off position. Once this is done successfully, a goodbye message will appear on the screen.

Alarm inhibit

To inhibit alarm detection at any time, move S1/7 to the on position. This could be used to avoid the Alarm Dialler immediately sensing an alarm condition if you are experimenting and changing the input connection or DIP switch settings. When the alarm input wiring and switch settings are in place, S1/7 can then be placed in the normal off position.

Switch S1/7 can also be used to manually reset an alarm after it has been triggered. When an alarm occurs, a software flag is set within the PIC and stored in EEPROM. The reason for this is to remember that an alarm occurred if there is a power outage during an alarm calling sequence. When power is reapplied and an alarm call sequence has not been completed, it starts the sequence again.

To manually reset the alarm flag, switch off power, place S1/7 into the on position, turn on the power again and move S1/7 back to the off position. The alarm flag is also reset each time you enter program mode to make changes to the configuration.

Configuring the modem

To ensure the modem you are using works properly with the Alarm Dialler, you must first configure it with the required settings. To do this, connect a PC running a terminal emulation program such as HyperTerminal to the modem, **using a standard serial**

Table 2: Modem Configuration	
Typical Command	**Required Options**
&K0	Disable RS232 data flow control lines.
S0=0	No auto answer - Alarm Dialler determines when the modem will answer a call by sending it ATA.
&D0	Ignore DTR lead on RS232 interface.
S7=20	Wait 20 seconds after making or answering a call before releasing the line when a carrier is not detected.
V0	Use digits rather than character strings for modem responses.
E0	Do not echo characters received by the modem back to the Alarm Dialler.
&W	Write the settings to non-volatile memory.

cable (ie, not a crossover type). Now type the letters **AT** followed by the **Enter** key.

If the modem receives and decodes this properly, it will respond with the letters **OK**. Now type **AT&F** and then **Enter** to reset the modem to its factory default settings.

Once this is done type the sequence **AT&K0S0=0&D0S7=20V0E0&W**, exactly as shown and terminate by pressing Enter. Notice that the 0 is a digit zero and not an upper-case letter.

If the modem accepts the settings, it will respond with a zero, indicating that all is OK. If not, and this is very unlikely, your modem does not recognise these standard commands. In this case, consult your modem's user manual and read the explanations in Table 2 to find and enter the commands that match your modem.

A modem option not shown in Table 2 but referred to throughout this article is the calling-tone option. Some modems will send a calling tone automatically every call, while some do not have this facility. Some others have the capability but require it to be enabled.

If you need this feature and it doesn't seem to operate, you will need to check your modem and see if it is an available option, or get another modem!

The time to wait online after making or answering a call is determined by the value in the modem S7 register. You may find that some modems actually wait longer then the programmed 20 seconds and you may not be able to make three calls within 90 seconds. If you find the wait is too long, then you will need to experiment with the value programmed into the S7 register.

Final testing

To fully check the Alarm Dialler functions, programmable settings and modem operation, you need to make real telephone calls. However, while call charges are relatively inexpensive, you probably don't want to make a lot of calls until you know everything is working OK.

We get around this problem by checking most of the Alarm Dialler functions without making any real calls. The way we do this is to simulate the actions of the modem using the PC.

First, to make life as easy as possible for testing purposes, set the alarm input up for N/O contacts as shown in Table 1. that way, you can later simulate an alarm condition just by shorting the two alarm input terminals.

Now for the test procedure. Start by programming the Alarm Dialler with Automatic mode set to Yes. That done, program the Primary and Secondary numbers to relevant telephone numbers, the 'Use secondary' option to Yes and the 'Retries' to 2. Once programming is finished, leave the PC connected using the serial crossover cable.

You will notice that after you exit programming mode the letters AT appear on the screen. This is the Alarm Dialler looking for a modem. Type the number 0 followed by the Enter key. When the Alarm Dialler receives this it thinks it has found the modem, starts flashing the LED and goes into scan mode.

At times during the remainder of the testing we will be simulating the sequence that the modem sends to the Alarm Dialler when it detects an incoming burst of ring. We do this by typing the number **2** on the PC keyboard, followed by the **Enter** key. An incoming call from the telephone line has a burst of ring every two seconds and so a 10-second call would be comprised of five bursts, each two seconds apart.

Checking that it's alive

The first test is to simulate calling the Alarm Dialler from a remote location three times within 90 seconds to check if it is alive.

Ensure the Alarm Dialler is in idle mode and that the LED is flashing normally. Simulate an incoming call for 10 seconds (ie, by repeatedly typing **2** and pressing **Enter** on the PC's keyboard) and check that the LED stops flashing after the first ring burst.

Now wait at least another six seconds and simulate another call. The LED should remain on and nothing else should happen. Finally, wait another six seconds and simulate a third incoming call. If the Alarm Dialler is working correctly, the letters ATA will appear on the screen and, after a cou-

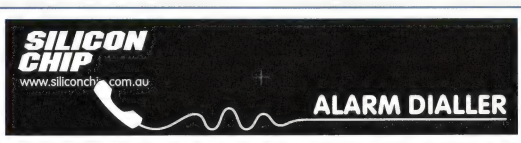


Fig.5: the full-size front panel artwork. There's just one hole to be drilled & that's for the indicator LED.

Fig.6: this full-size artwork can be used as a drilling template for the rear panel. The cutout for the DB9 connector can be made by drilling a series of small holes around the inside perimeter and knocking out the centre piece.

ple of seconds, the LED will start to flash again. The sequence ATA instructs the modem to go online and answer the call.

Checking automatic mode

The next test will check that Automatic mode operates correctly. First, simulate an alarm condition on the input. The screen should now show the letters ATDT, followed by the digits for the Primary number that you have entered during programming. The sequence ATDT is the command sent to the modem to tone dial the following number. Wait 45 seconds and the same sequence should appear on the screen again.

At this point the primary number has been dialled twice which is the number set in Retries. As we have set Use Secondary to Yes, the same delayed dialling sequence should occur again, however this time the Secondary number is used. Once all the calls have been made, the Alarm Dialler waits 45 seconds, operates the relay and the LED starts to flash normally.

Checking non-automatic mode

Once you are satisfied that Automatic mode is working correctly, you can test Non-Automatic mode. Program the Alarm Dialler with Automatic mode set to No, leaving everything else the same.

Simulate an alarm as before and check that the letters ATDT followed by the digits for the Primary number are seen on the screen.

Wait around 20 seconds and simulate an incoming call comprised of two bursts of ring. When the Alarm Dialler is in alarm mode it will only answer an incoming call after it has received two ring bursts. After the second burst, the Alarm Dialler should respond by displaying ATA on the screen, instructing the modem to go online and answer the call.

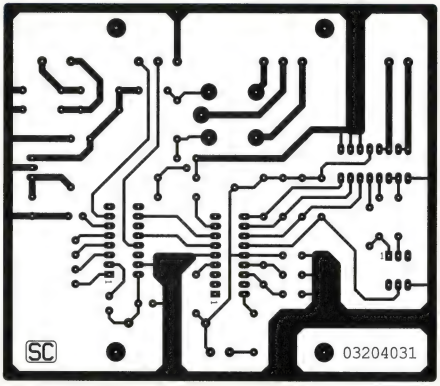


Fig.7: this is the full-size etching pattern for the PC board.

Wait 20 seconds and simulate a second incoming call in the same way. If the second call is detected the letters ATA should appear again indicating that the Alarm Dialler is answering the second call.

Finally, wait another 20 seconds and simulate a third incoming call. The Alarm Dialler should send ATA as before, however this time the relay will operate and the LED will start flashing. This is because three calls within 90 seconds have been registered in response to an alarm call.

If all these off-line checks perform correctly, you can be assured that the Alarm Dialler is working properly. If you want, you can test other features such as the failed call state, changing the number of retries and using the Primary number only and so on.

When you are satisfied that everything is OK, you can connect your modem to the Alarm Dialler and telephone line and test the system for real. Don't forget to reset DIP switch S1 to the alarm input option you require (see table 1). **SC**

Where To Get The PIC Software

To obtain the Alarm Dialler software, download the file "ALARM.ZIP" from the SILICON CHIP website and unzip it. You can use "ALARM.HEX" to program your own PIC chip, while you can get a better understanding of how it all works by reading the "ALARM.ASM" file.

Three do-it yourself PIC programmers

As well as releasing new Windows software and updated documentation for its existing low cost K81 parallel-port PIC16F84 programmer kit, DIY Electronics has also produced a completely new PICMicro programming kit (K149) which offers both serial RS-232C and high speed USB interfacing. Here's a hands-on look at both kits.

By JIM ROWE

MICROCONTROLLER CHIP maker Microchip Technology Inc has been phenomenally successful with its low-cost PICmicro family in the last few years. PICs are now probably used in more applications than any other family, as well as being embedded in a high proportion of smart cards. Small wonder that many people are keen to learn how to program them and get themselves a programmer.

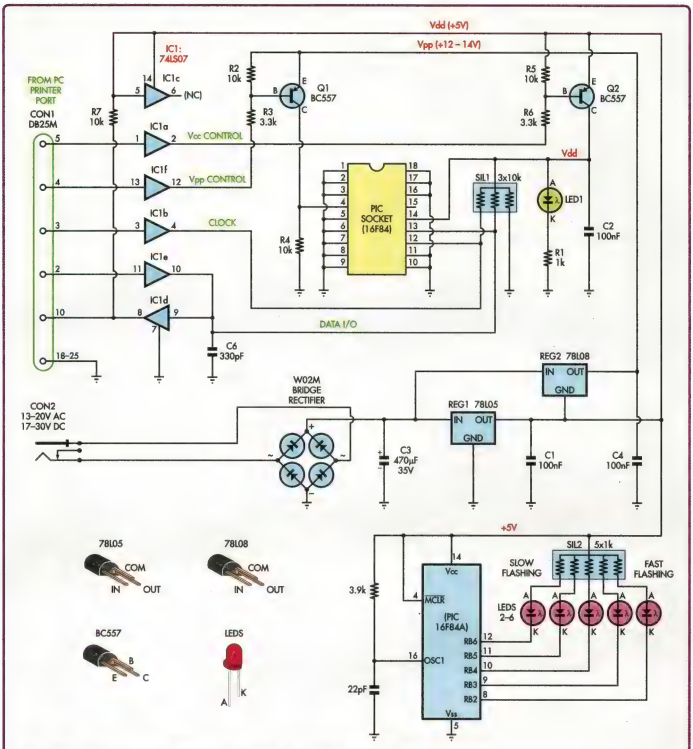
The most popular kind of programmer is one that's driven from a PC, probably because Microchip Technology has made available (for free downloading) an excellent suite of program development software called MPLAB which runs under Windows. So with a PC-driven programmer, you can develop your PIC firmware on the PC using MPLAB and then program it into a chip with a minimum of hassle.

A PC-driven programmer is the way to go then and the easiest and cheapest way to get one is to assemble one of the many kits that are now available.

In this article, we're taking a look at two such kits from Hong-Kong based DIY Electronics, which are available in Australia from Ozitronics. One is an updated version of DIY's existing low-cost introductory kit designed specifically for the very popular PIC16F84 chip. The other is a completely new kit which can not only be used to program many different PIC chips but also offers a choice of either RS-232C or high-speed USB interfacing to the PC.

The simpler kit

DIY's PIC16F84 Programmer & Ex-



PIC16F84A PROGRAMMER & EXPERIMENTER

(DIY K81)

Fig.1: the circuit details of the K81 PIC16F84A Programmer & Experimenter. IC1, a 74LS07 hex inverter, provides the interfacing between the PIC's programming socket and the PC's printer port. The test section is shown at bottom right – it flashes five LEDs, depending on the program loaded into the PIC's EEPROM.

perimenter kit (K81) was first released a few years ago and has been very popular. As well as providing a low-cost programmer which interfaced to the PC via a standard parallel printer port, it came with some DOS-based programming software, a sample PIC-16F84 chip and some simple programs. These programs demonstrated just how easily the PIC16F84 could be used as a simple LED chaser/flasher.

You could easily check out the operation of these programs too, because the programmer board included a "test circuit" area on the side, with a PIC

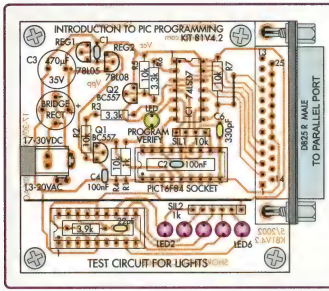


Fig.2: here's how the parts are installed on the K81 programmer's PC board. It's fairly simple and should only take about 30 minutes to build.

socket connected to a row of LEDs.

With these features, K81 made an excellent kit for anyone just getting into PIC programming and wanting a low-cost PC-based 16F84 programmer. That's still true, although in the last couple of years there's been a growing number of people who only have experience with Windows-based software and who also have little experience assembling electronic kits.

Understandably, these people found the DOS-based software a little unfriendly and required more guidance with the kit assembly. As a result, DIY has produced a revamped version of K81, with new and easy-to-use programming software running under Win9x/NT/2000 and an expanded 49-page manual. This not only gives detailed assembly instructions for the programmer but also works through the source code details of the four test programs, to help you understand how they operate.

The kit's hardware remains unchanged – it uses a well-proven circuit which is just as suitable for programming PIC16F84/A devices today as it was when first released. It uses Microchip's serial method of programming the chip's EEPROM, wherein the programming voltage (Vpp) is applied to the MCLR pin (4), serial programming data is applied to (and read back from) the RB7 pin (13) and programming clock pulses are applied to the RB6 pin (12).

How it works (K81)

Fig.1 shows the circuit details of the K81 PIC16F84A Programmer & Experimenter. It's really quite straightforward.

First of all, power for the programmer is derived from an external plugpack, which can be either a 17-30V DC type or a 13-20V AC type. A bridge rectifier is used both to protect against reverse polarity damage and also to rectify incoming AC. Regulator REG1 is then used to provide the +5V Vdd supply rail, while REG2 is "piggybacked" on this 5V rail to provide a +13V Vpp rail.

Interfacing between the chip's programming socket and the PC's printer port is provided via IC1, a 74LS07 hex inverter. This allows the PC software to control the Vdd voltage switching via pin 5 of CON1, inverter IC1a and transistor Q2. Similarly, the Vpp voltage switching is controlled via pin 4 of CON1, IC1f and Q1.

In addition, programming clock pulses are sent to the chip socket via pin 3 of CON1 and IC1b, while the programming data is sent to the socket via pin 2 of CON1 and IC1e. Finally, it can also read back data from the chip's EEPROM via inverter IC1d and pin 10 of CON1.

Note that because the inverters are of the open collector type, pullup resistors R7 and R8 are used to ensure correct operation.

At the bottom right of Fig.1 is the test circuit section of the K81 board. There are five LEDs connected between the SIL2 current limiting resistors and pins RB2-RB6 of the PIC socket, while the 3.9kΩ resistor and 22pF capacitor form a simple RC timing circuit for the PIC's internal clock.

Depending on the program you've loaded into the PIC's EEPROM, the LEDs either count up or down in binary fashion, glow in sequence from left to right and back again, or the LED connected to RB2 simply flashes on and off alone.

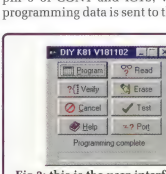


Fig.3: this is the user interface you get when you fire up the DIYK81.EXE program. The top four buttons are used to access the main programming functions: Program, Read, Verify and Erase.

Trying it out

DIY sent us a fully assembled K81 kit, so we were able to try it out with a minimum of fuss. However we did look through the assembly instructions, which form the first few pages of the kit's new 49-page manual. These are quite clear, so if you've built electronic kits in the past you shouldn't have any problems with this one.

The PC board overlay details are shown in Fig.2. It should only take you 30 minutes or so to assemble it.

Software (K81)

The software for the kit must be downloaded from the DIY website (**www.kitsrus.com**) and comes zipped in a single 1.32MB file (DIYK81.ZIP). When you unzip this to a temporary folder, it provides the necessary files, including a setup file, to install the main DIYK81.EXE program in any folder you nominate.

By the way, it's only when you have installed the main program that you discover the file K81.PDF, the electronic version of the kit's 49-page manual. This is one of the files that are unpacked during installation. So the next step is to open up the PDF file with Adobe's trusty Acrobat Reader and print it out to guide you the rest of the way.

In the same folder, there's also a file called DRIVER.TXT. This is a guide to installing the software drivers which allow the main DIYK81.EXE program to communicate with and control the

K81 hardware via a printer port. For systems running Win9x, all you have to do is right-click on another file called SETUP_9X.INF and then select "Install". This causes the appropriate driver files to be copied to the windows\system folder and away you go.

When you fire up DIYK81.EXE, it presents you with the small user interface shown in Fig.3. There are basically just eight control buttons, with the top four used to access the main functions: Program, Read, Verify and Erase.

The remaining four buttons are for selecting the printer port address, testing for correct communication with the K81 hardware, opening the online help file and stopping the programming prematurely. A small "progress bar" below the buttons shows that operations are proceeding.

It's all very straightforward and easy to use.

Initially, though, I couldn't get the program to "find" the K81 hardware, even though it was connected to the right port and powered up. I then realised that I had sent various documents to the printer via the same port, earlier in the same session. This can cause problems with other devices that interface via the printer port, as I discovered recently when developing my EPROM Programmer. I rebooted the PC and suddenly the DIYK81 software could now "see" the hardware. After that, it was all plain sailing.

The sample PIC16F84 programs that come with the software are supplied in both hex and assembler source code form, so it's very easy to program the sample PIC using any of the hex files. You do this simply by clicking on DIYK81's "Program" button and selecting the hex file you want from the dialog that appears. This then erases the PIC's EEPROM and programs it with the new hex file instead – an operation that only takes a few seconds.

Writing your own PIC16F84 software for programming via the DIYK81 software is quite straightforward too, if you follow DIY's advice and download a copy of the MPLAB software suite from the Microchip website (www.microchip.com). MPLAB is quite a big file (the current version 6.10 is about 25MB) and it has to be downloaded in floppy-disk sized chunks. But it's well worth getting, because it's a complete IDE (integrated development environment) which includes a source code editor, an assembler and linker, a simulator and a debugger.

It also includes programming software for Microchip's own PIC programmers, but the DIYK81 software performs this function with the K81 programmer.

Overall then, the K81 kit and its matching Windows-based software are very easy to use, and provide a low cost entry path for would-be PIC16F84 programmers. The new 49-page manual also provides a lot of good tutorial information, not just about building the kit but also on the basics of PIC assembly language programming, using the K81 sample programs as examples.

Considering that the K81 still costs less than $A40 from Ozitronics, this surely makes it excellent value for money.

USB PIC programmer (K149)

Good though it is, though, the K81 kit does have its limitations. For example, it only handles the popular

Where To Buy The Kits

Kits for the K81, K149 & K160 PICmicro programmers are available in Australia from Ozitronics (www.ozitronics.com) for the following prices:

K81 Parallel Programmer ..... $37.40 each (includes postage & GST).

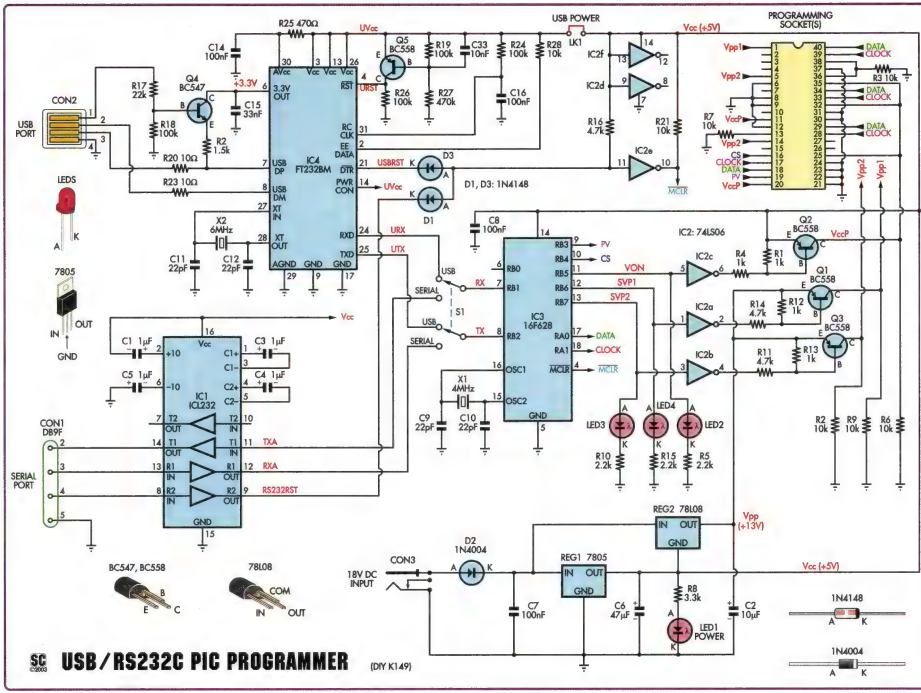
K149 USB/Serial Programmer ... $73.70 each (includes postage & GST).

K160 Serial Programmer ..... $28.60 each (includes postage & GST).

Contact Ozitronics as follows: phone (03) 9434 3806; mail 24 Ballandry Crescent, Greensborough 3088; email **sales@ozitronics.com**; website **www.ozitronics.com**

More information on these and other kits from DIY Electronics is available on their website: **www.kitsrus.com**. You can also contact the company by email at **peter@kitsrus.com**, if you have any suggestions to make regarding these or other kits.

Note that copyright of the PC boards and software source code for both the K81 and K149 kits is retained by the designers.



USB/RS232C PIC PROGRAMMER

(DIY K149)

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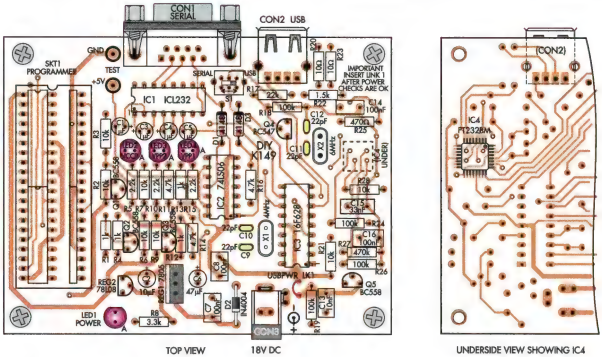


Fig.5: the K149 USB/RS232C PIC Programmer is built on a double-sided PC board. This board is supplied with FT232BM USB interface chip (IC4) already soldered in place on the underside.

PIC16F84/A chips, so it's not much use if you want to program one of the many other PIC micros.

The printer port interface may also be a problem with some late-model PCs, which often don't have a "legacy" parallel printer port at all. Apparently, it's assumed that you'll be either using a USB printer or printing via a network printer.

It's these limitations which have prompted DIY to develop the new K149 programmer kit, using hardware and software designed by Tony Nixon – **www.bubblesoftonline.com**. This kit will provide you with a much more "serious" programmer, which can currently support about 61 different PIC micro models. These include the 16F84/A, the 16F627/8, the 12C508/9, the 16C63A and of course many others.

The K149 doesn't just support a lot more PICs, though. It's also DIY's first kit programmer with a USB interface, so it should be fully compatible with virtually any of today's (or tomorrow's) PCs. It also offers an alternative RS-232C serial interface, which you can select by flicking an on-board switch.

So as well as coping with a wide range of PIC chips, the K149 should be useable with virtually any PC, old or new.

As you can see from the photo, the K149 programmer has a bit more in it than the K81. For starters, it's on a double-sided PC board about 50% larger than its little brother, with space for a wide-slot 40-pin ZIF socket for the devices to be programmed.

The kit actually comes with three 20-pin IC sockets to be installed on the board, but 40-pin ZIF sockets are available separately for those who expect to be doing a lot of programming. These ZIF (or "zero insertion force") sockets allow chips to be inserted and removed very easily, with much lower risk of pin or device damage.

Fig.4 (left): the K149 USB/RS232C PIC Programmer features both RS232 (MAX232) and USB (FT232BM interfaces. These forward and receive data to and from a pre-programmed PIC-16F628 (IC3), depending on the position of switch S1. IC3, in company with IC2, also provides the pulses to the programming socket.

USB interface

To provide it with the new USB interface, the K149 takes advantage of a fairly new "USB UART" chip from Scottish firm Future Technology Devices International (FTDI). The FT-232BM chip provides all of the circuitry required to transfer data between a USB port and a high speed asynchronous serial data line, in both directions and at speeds up to 3Mb/s (megabits per second).

The full details of this chip can be downloaded from FTDI's website at **www.ftdichip.com**

The FT232BM is in a very compact 32-pin LQFP (low profile quad flat pack) surface-mount package, with leads spaced only 0.8mm apart. However, to save inexperienced constructors from getting into strife soldering this tiny chip's leads, DIY Electronics supplies the K149 board with the FT232BM chip already pre-soldered in place on the underside copper. All you have to do is mount the larger parts on the top of the board.

To allow the K149 programmer to cope with the various PIC chip models, its control circuitry is based on a pre-programmed PIC16F628 chip. This takes the data and control instructions coming to the programmer via either the USB or RS-232C interfaces and controls the programming/

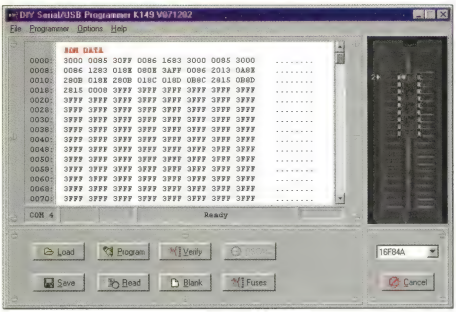


Fig.6: this is the main user interface for the K149 programmer. As well as the control buttons (arranged along the bottom), there's also a large text box where you can examine hex program listings – either before programming or read back from a programmed PIC. There's also a picture box (far right) which shows you how to plug the selected PIC into the K149's programming socket.

verifying/reading operations accordingly.

Circuit details

Fig.4 shows the circuit of the K149 USB/RS232C PIC Programmer.

The RS-232C serial interface is provided by IC1, which is an ICL232 level translating transceiver device very similar to the well-known MAX232. The USB interface is provided by the FT232BM (IC4), which uses a 6.0MHz crystal to lock its USB clock oscillator (multiplied to 48MHz via an internal PLL).

IC3 is the pre-programmed PIC-16F628, which receives the incoming serial data at its RB1 pin (7) and provides return data via it RB2 pin (8). As you can see, these pins are both switched using S1 to communicate via either IC1 or IC4 – ie, S1 provides the USB/RS232C mode selection.

Inverters IC2a-IC2c (74LS06) are used to control transistors Q1, Q3 & Q2 respectively. These switch the Vcc supply and the Vpp supply (x2) to various pins on the programming socket. This all takes place under the direction of IC3, via pins RB5-6-7.

LEDs2-4 are used to indicate when these voltages are being applied to the socket.

Inverter IC2e is used with diodes D1 & D3 to form an OR gate. This allows the PC software to reset the programmer's 16F628 (IC3) when desired via the interface (USB or RS232) that's is being used. As shown, IC2e's output is connected to the MCLR-bar input of IC3 (pin 4). The remaining two inverters inside IC2 (IC2d & IC2f) are not used and have their inputs tied high.

The power supply section is very similar to that used in the K81, with piggybacked 7805 (REG1) and 7808 (REG2) regulators to provide the +5V and +13V rails. The only difference is that they're fed via a single series protection diode (D2), instead of a full-wave bridge rectifier. This means that the K149 should only be powered from a nominal 18V DC plugpack.

Trying out the K149

DIY again supplied us with a pre-assembled K149 kit, so we could try it out with minimum hassle. As before, we looked at the assembly instructions and although fairly brief, they should be quite adequate for anyone who has previously assembled electronics kits.

Fig.5 shows the parts layout on the double-sided PC board.

Trying it out

We decided to test the K149 using the USB interface, because this is probably the most interesting feature of this kit. There weren't any real problems, although there was initially a minor hassle in connecting the programmer up to a USB port of the PC we were using for evaluation.

That's because we had to get a special USB cable to link them up, as the programmer is fitted with a USB Type A socket – ie, the "flat" type normally used only for the host PC ports in a USB network or the output ports of a hub. This means that you can't use a standard USB cable with a Type A plug at one end and a Type B "square" plug at the other – instead, you have to use a special cable with Type A plugs at both ends.

However, these cables are readily available from a number of local suppliers. We obtained one and were then able to connect the K149 to one of the PC's USB ports.

The main software to operate the K149 again needs to be downloaded via the web, in this case from **www.crowcroft.net/kitsrus/**. It's a single 1.7MB file called K149DISK.ZIP.

When you unzip this file, it produces two smaller zip files which then have to be unzipped in a temporary folder. This gives a set of files (including SETUP.EXE), after which you can install the main software files on a folder of your own choosing. The main program is called MicroPro.EXE, which currently runs under Win9x/NT/2000.

If you're going to be using the USB interface, you also need to download and install the USB drivers which allow Windows to communicate with the programmer's FT232BM chip. These must be downloaded from the FTDI website at **www.ftdichip.com/FTDriver.htm**. The drivers to get are called "VCP Drivers for Win98/2000/ME/XP (without PnP support)" and they come zipped up in a single file.

While you're at the FTDI site, it's also a good idea to get the installation notes which are in PDF format. These are at **www.ftdichip.com/FTApp.htm** – be sure to get the one for your particular operating system.

Once you have downloaded the USB drivers, you unzip the files into a "USB" subfolder, just below the one where you installed the MicroPro software. When you subsequently power up the K149 board and connect it to one of the PC's USB ports, Windows senses its presence and prompts you to install the appropriate USB driver – it's just a matter of going to the

\K149\USB folder, where you just unzipped the drivers.

This basically installs the programmer on a high-speed USB-supported "virtual serial port", which in my case turned out to be COM4. When you fire up the MicroPro software, it can then communicate with the programmer once you select that port.

The K149 software

Not surprisingly, the MicroPro software that comes with the K149 is more complex than that supplied for the K81. That's because it has to cope with a wide range of PIC chips. However, it's still quite friendly and easy to use.

Fig.6 shows the main user interface. It has a similar set of programmer control buttons along the bottom but now there's also a large text box where you can examine hex program listings – either before programming or read back from a programmed PIC. To the right of this box, there's also a picture box where you first see an image of the K149's programming socket.

At first, I was a bit confused about the correct placement of a PIC to be programmed in the K149's socket, because this wasn't indicated either on the K149 board itself or in the documentation. Nor could I find where you selected the type of PIC to be programmed on the MicroPro user interface (it wasn't evident on any of the top pull-down menus, for example).

It was then that I discovered the purpose of the small uncaptioned drop-down list box near the bottom right-hand corner, just above the Cancel button. Clicking on its drop-down arrow brings up a list of all supported PICs – and when I selected one, the picture in the box above changed to show the correct way to plug that device into K149's programming socket.

It's a very neat feature – except for the lack of a caption on the drop-down list box.

After that, I had no problems at all using the K149 and MicroPro to program PICs. And thanks to the USB interface, it programs them very quickly and efficiently.

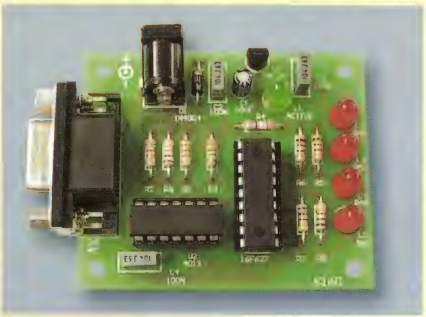
It turns out that MicroPro even provides a "Fly Window" option, to allow you to program PICs directly from MPLAB once you've written a program and assembled it. When you select the Fly Window option, MicroPro produces a little "remote control" dialog and minimises itself. Then, when you're in MPLAB, the small dialog allows you to access MicroPro's Program and Verify functions – which is also very neat.

Summary

My impressions of DIY's new K149 programmer are very favourable indeed, apart from those little niggles about the need to get a special USB cable and the software's unmarked list box to select the PIC device you want to program. Those points aside, it gives every evidence of being well-designed and it is very easy to use.

So if you're after a fast and convenient PC-driven programmer for most of the commonly used PICs, the K149 can be recommended. It's also a very cost-effective way to get yourself such a programmer, because the K149 sells in Australia for only $73.70 (including postage & GST). The pricing panel has all the details. **SC**

K160: PIC16F62x Experimenter & Programmer



Also recently introduced by DIY Electronics is the K160 PIC16F62x Experimenter & Programmer kit, designed for programming the PIC16F62x series of PIC chips (ie, 16F627, 16F627A, 16F628 & 16F628A). The 16F628-04/P chip is used in the kit.

As well as programming PIC16F62x chips, the kit is also designed to teach you the basics of programming. It comes complete with the following:

- a Windows 9x/NT/2000/XP user interface;
- Five detailed code examples to flash LED's; and
- A 40-page PDF (Adobe Acrobat) file which introduces the MPLAB program from Microchip for program development and assembly.

The K160 Programmer connects to the serial port of the PC. You simply program the 16F628 using the user software provided. The software then runs immediately and flashes the LEDs on the board.

Fully-commented source code is provided for the example programs: binaryup.asm, binarydn.asm, binarylr.asm and flash.asm. These programs flash the LEDs in a variety of patterns. The compiled object code is also provided (ie, the hex files).

Kits for the K160 IC16F62x Experimenter & Programmer are available from Ozitronics – see price panel. For further information on the kit itself, visit the DIY Electronics website at **www.kitsrus.com**

Remotely triggered photography

Electric Camera Shutter Release

By Julian Edgar

Triggering a camera remotely allows you to take photos that might otherwise not be possible: dangerous locations or situations, wildlife photography and so on. You could also generally improve your photographic creativity. But how do you press the shutter release from a distance?

ONCE, ALL CAMERAS had a female cable release thread in the shutter release button, allowing the use of a long (often pneumatic, sometimes electric) cable release to let you to trigger the camera from afar.

But these days, plenty of cameras (most?) don't have this facility. In some cases, you can buy a dedicated electric cord that plugs into the camera – but you'll certainly have to pay big dollars for it.

Remotely triggering a camera – any camera – is a problem no longer! What we have here is a simple and cheap DIY project that will allow **any** camera to be fired from a good distance. With a little ingenuity it could even be adapted for radio control.

The camera doesn't have to be fitted with a threaded shutter release button and it doesn't need a socket for an electrical cable release. In fact, all that it really needs to have is a tripod mount (we haven't found a "real" camera yet that doesn't!) and a button that gets pressed to take the picture (ditto!).

It uses a small solenoid – a device which consists of a

coil usually wound around some form of armature or plunger. When the coil is energised by current, the armature moves due to the magnetic attraction (or repulsion) of the coil. It is this movement which is used to push the camera release button.

The design

The solenoid is mounted so that its extended plunger pushes the camera shutter release button. A mount for the solenoid – folded from aluminium sheet – is attached securely to the camera via a screw into the tripod socket. The solenoid is fired by the use of a pushbutton switch mounted on a remote handpiece which also contains one or two batteries.

The solenoid used here was salvaged from an electric typewriter. Pretty well any small solenoid can be used – so long as it has an adequate amount of 'push' and can be operated at low voltage. The handpiece was made from an old personal deodorant container, while the pushbutton, battery clips and cable were bought specifically for the project. But you might even have these in your junk box!

So depending on how you source the parts, this device shouldn't cost much at all.

Building it

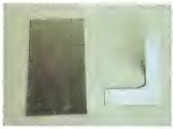
1. The Bracket

The typewriter solenoid selected for this project normally pushes the daisywheel letter against the ribbon and paper. To facilitate this, the plunger of the solenoid has a groove machined in its end. This results in a sharp edge – not really what you want striking your camera's shutter release button!

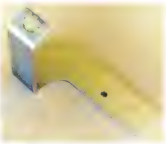
To get rid of these sharp edges the solenoid was disassembled and the plunger end smoothed with a file.

Once that was done, a piece of cardboard was cut out and formed into a template for the bracket. This bracket needs to place the solenoid at the right angle and position so that as the plunger extends, the shutter release button is depressed. In the case of this Nikon F60 SLR, this required an 'L'-shaped bracket which was then folded into the right shape – see photos.

With the shape organised, a piece of scrap aluminium sheet was marked out and then cut to shape using an electric jigsaw. The sheet is 2.5mm in thickness – strong enough to have the required stiffness but still light and easy to cut and bend. Note that offcuts of sheet aluminium are available from non-ferrous scrap metal dealers very cheaply.

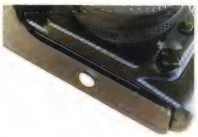


They'll cost a lot more if you go to a specialist aluminium supplier!



The piece of aluminium was then bent to the right shape in a vice and the holes for the solenoid and tripod mount drilled.

The mount was painted black, and a short ¼-inch screw used to attach it firmly to the camera tripod mount.



This shows how the solenoid is positioned so that its plunger is at the right angle to push on the shutter release button.

A long cable is used to join the solenoid to the handpiece, as shown below.

2. The Handpiece

How you make the handpiece depends a little on the amount of "juice" you need

to actuate the solenoid. This can be best found out by actually triggering the solenoid when it's in place on the bracket. When operated on the bench, a solenoid may work perfectly well on 9V (or lower), but with the voltage drop of a long cable and the effort of having to push the camera's shutter release button, more voltage might be needed.

I found this out the hard way: the typewriter solenoid bench-tested fine on 9V, so I built this small hand controller using a commercially available box and a single 9V battery. But this system simply didn't have enough power to trip the camera!

Time for a rethink. Because the power is applied in such a short burst (you should never leave you finger resting on the button), much higher voltages than the normal working voltage of the solenoid can be used without problems. In my case, I simply used two 9V batteries in series, giving 18V output. That triggered the solenoid decisively and hard!

The new handpiece was made from a deodorant container – emptied of course!

The two 9V batteries – complete with their battery clips – fitted into it very nicely, while the pushbutton switch was placed through a hole drilled in the cap. Making a battery change is as easy as lifting off the cap and sliding the old batteries out but they should last for ages, depending how much you use the remote trigger.

Using it

It makes things a lot easier if the camera that you are using has an inbuilt motorised wind-on. But other than that, just about any camera can be used. The camera should be pre-focused – and the auto focus disabled if possible – and in some cameras the viewfinder should be blocked (eg, using a rubber cap) to prevent extraneous light from causing metering problems.

Then it's simply a case of setting up the camera (you should still be able to use a tripod if required, with the tripod threaded fitting long enough to go through the alloy plate), standing back and pressing the handpiece button at the right moment.

Digital cameras

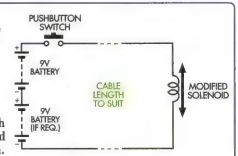
This project is just as suitable for use on a digital camera, with one important proviso: most digital cameras require a significantly longer "firing" time than conventional cameras – the best are about 100-200ms, while many of the "happy snap" (ie, cheaper) variety require half a second or so. Therefore, you will need to experiment with the release to determine just how long you need to hold the button down to get your picture.

The earlier comments about turning off auto focus, etc, still apply – that is, if you can manually focus the camera. Some simply don't let you!

Also note that apart from some cheap digital cameras, most are capable of being remotely controlled via their bus. However, the chances of finding a remote control cable in your new camera box are pretty slim and the earlier comments about the cost of special cables certainly applies to digital cameras – if not dramatically more so!

This project is definitely a cheaper alternative, especially if you can scrounge the parts! **SC**

The circuit could hardly be simpler – that's the beauty of this project. Whether you need one 9V battery or two depends on both the solenoid and the cable length.



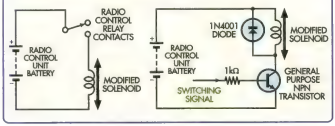
Radio Control

We mentioned earlier that this project could be adapted to radio control with a bit of ingenuity. In fact, it's not rocket science: just about any of the remote controls we have recently published could be used.

All that is required is to wire the output device of the remote control receiver, whether that be a relay or a switching transistor, in place of the pushbutton switch (as shown below). You may well find that the battery required to power the radio receiver can also power the solenoid.

The radio control must be set for momentary (as distinct from alternate) action. It needs to actuate when you press the button and let go when you let go the button. (Alternate action requires two pushes of the button to actuate and then let go).

One point to note: the solenoid, being a coil, generates a significant back-EMF when the power is removed. This won't worry either a pushbutton or a relay contact but could be disastrous for a switching transistor. If unsure, place a reverse-biased small power diode (1N4001 etc) across the solenoid coil, with its cathode (the banded end) towards the positive supply.



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PRODUCT SHOWCASE

Gigabit Ethernet Switch and Interface Card

It's all very well having a 100Mbs office network but if lots of users are trying to access a single server at the same time, things can get very slow indeed.

The answer to this problem is to have a 1-gigabit link to the server to eliminate this bottleneck but until recently, such links have been quite expensive. Not any more – prices have fallen over the last six months and the hardware is now quite affordable.

Slotting into this category is the Edimax ES-5108D Fast Ethernet switch from MicroGram Computers. This switch features a single 1-gigabit port plus eight 10/100Mb ports, all capable of operating at both full and half duplex. All ports are auto-negotiating and an array of LEDs on the front panel indicates port status.

The unit comes in a solid metal case, has its own internal power supply and comes complete with a power cord and a users manual.

Of course, having a 1-gigabit port is not much use without a matching interface card at the other end – ie, in the server. The Edimax EN-9210TX 1-Gigabit Ethernet Adapter is suitable here. This 32-bit card plugs into a standard PCI slot, can operate both full and half-duplex, is fully auto-negotiating and supports Windows 98/Me/NT/2000 Netware Server 4/5 and Linux.

Supplied with the card are all the necessary drivers for these operating systems plus an instruction manual.

The Edimax ES-5108D Fast Ethernet Switch (Cat. 11353) costs $639.00 (incl. GST), while the Edimax EN-9210TX-32-Gibabit Ethernet Adapter (Cat. 11359) sells for $139.00 (incl. GST). For further information, contact MicroGram Computers, PO Box 8202 Tumbi Umbi, NSW 2261. Phone (02) 4389 8444, fax (02) 4389 8388 or visit **www.mgram.com.au**

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It can make 100 different parametric measurements in eight specific test categories within 10 seconds so that product performance can be objectively assessed. It also offers a unique high-definition matrix test signal set for the creation of standardised test signals including colour bars, multi-burst, sweep and five other signal types, for testing in Y/Pb/Pr and RGB color space.

Contact NewTek Sales Pty Ltd on (02) 9888 0100 for more information.

The mother of all remote controls

Is your coffee table littered with remote controls? Get rid of them and just use this single remote control instead. It can control up to 16 audio-video devices – including a TV set, DVD player, CD player, satellite receiver and VCR – and features a touch-sensitive backlit LCD panel, making it perfect for home theatre set-ups.

Press a button to select a device and the large LCD panel instantly changes its control icons to suit. The device comes programmed with a huge range of popular remote control codes and for most devices, it's simply a matter of entering a 4-digit code from the supplied list.

Alternatively, the unit can be used to select the code automatically during setup or it can learn from your existing remote controls.

Other features include a macro function (up to 60 commands), automatic switch-off, the ability to relabel individual devices and the ability to classify channels into groups (eg, news, movies, etc). It even has an inbuilt clock and calendar.

This mother of all remote controls is available from Altronics for $269.00 (Cat. A 0990) for $269.00. Phone 1300 797 007 or visit **www.altronics.com.au**

2-Channel Digital Oscilloscope

Yokogawa has recently introduced the DL1620 2-channel digital oscilloscope, featuring 200MHz bandwidth and a maximum sampling rate of 200Msample/s.

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The DL1600 offers three types of removable media: floppy disk, ZIP disk or Type II PCMCIA card and comes with an inbuilt printer as standard. The maths function computes values in real-time when the instrument operates in roll mode. That means that when measuring slow signals, the calculated values are determined and displayed immediately, rather than having to wait for the measurement to finish.

Inbuilt probe power for use with Yokogawa's current and differential probes is optionally available. And an optional Waveform Viewer program lets users view waveform signals on a PC just as they appear on the DL screen.

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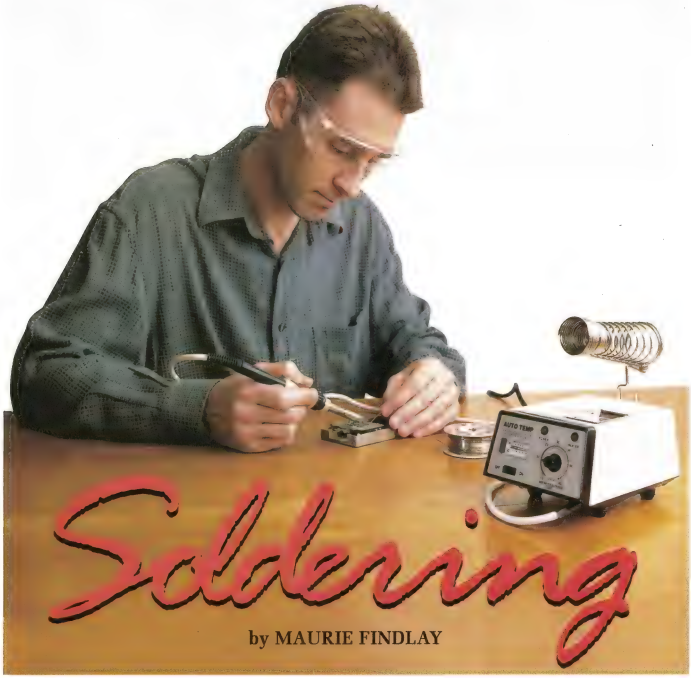
It's one of the fundamental skills in electronics, required at every level from beginner to rocket scientist. Everyone knows how to solder . . . or at least think they do! Yet kit suppliers will tell you that 99.9% of failures in home-built kits are due to poor soldering. Let's try to help lower that statistic!



Soldering

by MAURIE FINDLAY

ALMOST ALL OF the constructional articles appearing in SILICON CHIP involve soldering to make electrical connections.

With modern tools and solder, most readers are able to do a good job. However, an understanding of the soldering process, plus some practical experience, can make for reliability and professional appearance.

Typically, a project will involve a PC (printed circuit) board plus some ICs, discrete transistors, diodes, resistors, capacitors and so on: all new and shiny with leads finished with materials specially designed for easy soldering.

You have a length of solder wire and a small soldering "iron". The solder is placed to touch, say, a resistor lead and PC board track to be joined. The soldering iron tip is applied to the solder (more often than not, in the form of a thin wire). The solder wire melts and molten solder flows over the two component leads. The soldering iron tip is then moved away and the solder solidifies in a few seconds and leaves a reliable connection.

In most cases, it is that easy. But it's not always so. For example, the solder may not flow over the component leads – it may look like it has but the lead is not actually coated. Or it may have moved before the joint solidifies. Or the heat of the solder might have damaged the component . . .

Soldering is not quite as simple as it sounds. For this reason, it's well worth knowing a bit more about the fundamentals of soldering so that you can handle situations which are not so straightforward.

In the electronics industry, solder is used to make the majority of electrical connections. Even an ordinary domestic television receiver may contain thousands of connections between components, PC boards and cables and in most cases the failure of one connection can make the receiver inoperative.

Satellites, military equipment and so on make use of solder joints in much greater numbers – and require even greater reliability. It's not easy whipping out the hot stick when the PC board is a few hundred kilometres out in space!

But so much have soldering techniques improved over the years that most electronic equipment is now extremely reliable.

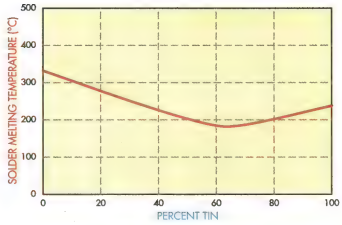


Fig.1: solder, a mixture of lead and tin, has a lower melting point than either lead or tin. Lower heat means less likelihood of damage to sensitive components.

LEAD MELTS AT 327°C, TIN MELTS AT 232°C.
SOLDER ALLOY OF 62% TIN & 38% LEAD MELTS AT 183°C

What is solder?

First of all, a fundamental question: what is solder ?

Solder is an alloy, or mixture of metals, used for joining other metals. While general-purpose solder is almost always a mixture of tin and lead, other metals can be included for special purposes.

For example, a small amount of copper is sometimes added to help preserve soldering iron bit life. And there are specialised solders which don't contain any lead at all. But they are not the types you will normally come across in electronic work.

The tin and lead are closely mixed together but not chemically bonded. The tin-lead alloy has a very useful characteristic – it melts at a lower temperature than that of tin or lead alone. What's more, the melting point can be controlled by altering the proportions of the two metals.

For fine electronic work, an alloy of 62% tin and 38% lead (by mass) is a good choice. It melts at 183°C, much lower than for either metal alone (lead melts at 327°C and tin at 232°C). This lower melting point means that there is less chance of damage being done to components, the PC board and other parts.

At the other end of the scale, a different tin/lead mix solder is used for joining sheet metal. Examples are galvanised iron roofing components and tin-plated food containers.

Plumbers use solder in relatively large quantities and there usually isn't

A beginner's general-purpose soldering kit, with a 25W mains-powered iron, a soldering iron stand complete with tip-cleaning sponge, a roll of de-soldering wick and a some solder. All up? – about $35.00. (Courtesy Jaycar Electronics).

Facing page: the budget-priced "Auto Temp" soldering station. About $185 from Dick Smith Electronics.

This Micron 60W temperature-controlled soldering station from Altronics has a LED readout to tell you the exact tip temperature. You can dial up the temperature you want and it will hold it there within 2°. It includes the tip cleaning sponge shown but the solder holder on top is an option.

a problem about overheating the components being soldered. The solder sticks they use may be about 300mm long and up to 80mm^2 in cross section. Lead is cheaper than tin and an alloy of 50% tin and 50% lead, melting at 210°C, is used.

Flux

Sheet-metal solder should not be used for electronic work – not so much because of the different alloy mix but because of the type of flux used (if at all).

By far the majority of solder you will use in day-to-day electronics work has more in it than tin, lead and perhaps some other metals. Down the centre of the solder wire, in tiny hollow tubes, there is flux.

Flux helps the solder to flow and to "wet" the metal being soldered, especially the more difficult-to-solder metals. Because the flux melts along with the solder, exactly the right amount is applied to the joint as you solder it.

Most general-purpose flux is made from rosin – often (but wrongly) called resin. The flux itself is a resin, made from rosin. Thoroughly confused now?

You need to remember that as the flux melts, it releases fumes and these fumes may adversely affect some people. There is also some evidence that melting solder releases lead fumes which could also be dangerous. The moral of the story – don't breathe in fumes when soldering.

Incidentally, you can buy nifty little fan units which suck fumes away from your soldering area. If you're worried about your health, they are worth looking at.

Before finishing with flux, there is another common type of solder (the type you find in hardware stores) which contains an acid flux and is intended for sheet metal work.

Never use this for electronic work – the acid will quite quickly eat away the copper on the PC board and probably the component leads as well.

Tools

OK, so what do you need besides the solder? For starters, you need a soldering iron) and perhaps something to remove solder if you inadvertently put a component in the wrong place.

Some fine tweezers to hold components in place and a heatsink to clip onto the leads of heat-sensitive components would be worthwhile extras.

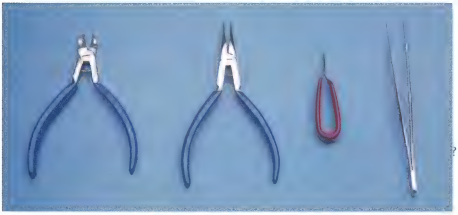
A heatsink, by the way, is merely a device to draw away heat from a device's lead(s) so that the heat from the soldering iron doesn't reach the sensitive parts of the device. Heatsinks are often made like alligator clips (but with flat blades, rather than serrated teeth), which clip onto a device's leads under spring pressure.

Which iron?

There are lots of soldering irons to choose from. At the bottom end of the scale, a simple tool will set you back about $20 or less and will do a good job if your only need is to assemble a few PC boards with small components.

Typically, it will plug directly into the 240V mains, will be rated at 25-40W, and will be set up for a tip temperature of about 370°C. This temperature is about right for most situations, considering the losses in transferring heat to the components.

The disadvantages of some "el cheapo" irons may not be obvious – after all, they solder, don't they?



A very basic selection of hand tools but probably all that the novice constructor needs. On the left is a pair of sidecutters (sometimes called nippers or nipping pliers); next is a pair of needle-nose pliers. The red gizmo is a heatsink (these come in various shapes and sizes) while rounding out that group is a pair of pointy-nose tweezers. At right is a set of flat-nose and Philips screwdrivers. They are bigger than "jewellers" screwdrivers but not much bigger – a hobbyist would normally have some larger flat and Philips (or Pozidriv) screwdrivers. All of these tools are from Jaycar Electronics.

Well, yes . . . but cheap irons sometimes are too hot for very small components, yet not able to maintain a high enough temperature to ensure good, sound joints with larger ones.

Electrostatic damage

Some cheap mains-powered irons (and even some more expensive ones!) can cause damage to some sensitive components due to electrostatic discharge. This can occur if the iron tip is not properly earthed (and even irons which are properly earthed when new can develop this problem with age).

What happens is that a relatively high electrostatic voltage builds up on the iron tip which can exceed the rating of the component being soldered. The result: one "cooked" component – and not by the heat of the iron!

To avoid this problem you can run a strap (such as a length of wire fitted with two alligator clips) between the barrel of the iron and the earth plane of the job.

Next up the list is a similar type of iron but with some sort of temperature control. A power rating of 60W would be typical and the maximum temperature set would be around 350°C. This will handle bigger jobs than the $20 iron while being kinder to very small components.

You could expect to pay more than $100 for a simple temperature-controlled iron, powered directly from the mains. The comments above regarding an earth strap still apply.

The next step up in temperature-controlled irons gets us into real money – but you get what you pay for. If are doing quality work over a period of time, you should consider a variable temperature-controlled iron (actually they're normally called "soldering stations") in the price range $200-$500.

There are quite a few brands to choose from. Most operate through a mains transformer, with the heating element rated at 24V and about 50-60W.

The tip temperature is controlled by a circuit which switches the power on and off. In some cases, the switching action happens as the AC voltage passes through zero, ensuring that no transients appear at the tip.

You can set the actual temperature via a control knob – some have a scale behind the knob while others provide a digital display for the set temperature.

It might say "for soldering and tinning most metals" but this soldering fluid – and most fluxes – are a definite no-no when it comes to electronics. The roll of solder at right might look the same as you see at your electronics shop but this higher-melting-point type is meant for copper pipes, etc. It has a 50/50 tin/lead mix (instead of the normal 62/38 mix) and is also quite a lot thicker than most electronic solder.

The beauty of a temperature-controlled iron is that its tip temperature stays much closer to that set, whether the iron is at rest or supplying its maximum heat.

Weller produces a relatively inexpensive but very reliable soldering station that uses a series of tips to select the temperature. The system makes use of the "Curie" effect, where a metal can be designed to lose its magnetic properties at a particular temperature. Unfortunately, this system does not allow for zero voltage switching.

There are other versions of electric soldering irons which don't run from the mains (well, not directly anyway). These use batteries (usually, but not always, rechargeable via a mains plugpack or adaptor) and are handy for use away from a power outlet.

Other versions of low-voltage irons run from 12V and are designed to operate from a car battery – either connecting directly with large alligator clips or plugging in via the cigarette lighter. These are obviously intended for automotive uses.

Gas irons

Just to complete the story, we must consider gas-powered soldering irons. They are not too expensive and are very handy for doing a small amount of work where it is difficult to set up an electrical supply – eg, service work in the field.

Butane gas, supplied from an internal reservoir, burns to heat the tip. They will usually operate for about an hour on a single refill and at a moderate temperature. However, they are a bit fiddly and you normally wouldn't consider them against the electric version for general bench work.

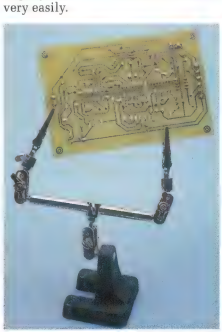
Suckers!

Whether it's to remove solder on joints soldered incorrectly (hey, we all make mistakes!) or to remove faulty parts, a "solder sucker" is all the go.

It is a cylinder with a piston, the latter set in sharp motion by a spring. Air is sucked into the cylinder via a tip that concentrates a partial vacuum above the molten solder, drawing it into the cylinder. These usually sell for between $10 and $20.

There are also professional solder suckers which have an electric vacuum pump but these generally cost the earth. While not out of place on a service bench, they're overkill for most hobbyists.

Smaller amounts of solder can efficiently be removed from PC boards, in particular, by means of de-soldering wick. This is a woven copper braid impregnated with flux, which solders very easily.



As you start to build more projects, devices such as this mechanical "third hand" become almost essential. The PC board can be held at any angle and, importantly, easily flipped over for soldering.

Typical of gas irons, this "Vulkan" from Jaycar is very handy if you're away from a power source. They run from butane gas which can refill the iron in seconds.

You place the braid over the soldered joint and then apply the iron – the braid sucks up the solder from the joint (just like a wick, hence its name).

Other tools

Pliers and tweezers for holding and bending components can be very handy aids to soldering – but don't go overboard and purchase every one in the catalog until you are sure of what you actually need.

In general, the hobbyist can get away with one pair of fine (needle-nose) pliers, one pair of heavier pliers, one small pair of sidecutters and (perhaps!) one larger pair of sidecutters. Usually (though not always), you get a better tool by spending a bit more money.

We mentioned heatsinks before. They are essential if you are dealing with components which may be damaged by high temperatures. Heat that would otherwise flow the length of the lead is shunted to the heatsink and the component kept cooler.

Most small parts, including semiconductors, can be soldered safely without a heatsink, provided the usual 60/40 solder is used and the joint made quickly.

Lets start soldering!

Now let's look at the actual technique of making a good solder joint. First and foremost, the parts to be soldered must be clean – oxidation of component leads and PC board tracks is one of the main causes of poor solder connections.

Sometimes we have to use components that have been stored for a long time or for some other reason do not "tin" easily. And believe it or not, many a solder joint has failed simply because the clear insulation on the wire (eg, on coil wire) was not scraped off.

The idea is to get the surfaces mechanically and chemically clean by removing oxides, sulphates and other substances that may come from handling or from the atmosphere.

Bright copper (and bright tinned copper) solders very easily. Oxidised copper and tin does not.

Wiping with a clean rag will often do the job. Stubborn cases may need a touch of fine emery paper or even scraping with a blade – but beware of too much abrasion if you are dealing with plated components.

The wires should be bright and shiny before soldering. If in doubt, do a "trial run", pre-soldering the wires to see if the solder takes properly. If it doesn't, you don't have much of a chance of making a good soldered joint.

The main point to keep in mind is that both of the parts to be joined must always be raised to a temperature above the melting point of the solder. Ideally, the tip of the soldering iron would be applied to both parts, left for the necessary short time and then the solder wire (with its resin core) applied.

The resin melts, spreads across the surface with a cleaning action, followed by the molten solder. The soldering tip is then removed and the solder solidifies to give a sound mechanical and electrical joint.

If, as is the case with most modern small components, they wet very easily with the molten solder, it is OK to place the solder wire across the parts to be joined, and apply the iron to the solder wire which then melts and, by conduction, raises the temperature of both parts to the necessary temperature. This is exactly what we do when assembling PC boards: touch the joint with the solder wire, apply the iron, remove the iron, wait a sec and bingo!

Just to get things into perspective, easy to solder metals include: gold, tin-lead, tin, silver, palladium and copper.

Slightly harder to solder are brass, bronze, Monel and nickel silver, while metals that are difficult to solder include Kovar, nickel-iron, nickel, steel and zinc.

Metals that are almost impossible to solder without special techniques and/or equipment include aluminium, alloyed steel, chromium, magnesium, molybdenum, tungsten and beryllium.

Some components may have tin-plated steel leads. The steel wire provides the mechanical strength needed to support the component while the tin plating makes it easy to solder.

Sometimes, and particularly in the case of high-density ICs, the coating of easy-to-solder material is only a few microns thick and gentle cleaning methods are required. If you remove the coating, it may be impossible to make a good joint at a temperature that is safe for the component.

Other methods of soldering

With the increasing complexity of electronic equipment, assembly methods and soldering techniques have undergone a revolution.

These two solder suckers from Jaycar are typical of spring-powered, low-cost models. On the left is an economy type with plastic body, while the one on the right is of metal construction. Both have high-temperature, replaceable Teflon tips. Powered solder suckers are also available.

Component and equipment manufacturers go to enormous trouble to ensure that their products are easy to solder and reliable. Most of the advances in soldering techniques have occurred over the last 40 years or so, in parallel with the increasing sophistication and reliability of semiconductor devices.

Before then, most components had wire leads and were strung between tag strips, switches, valve sockets and so on. Interconnections between various parts of the circuit were made with wires and, when there were a number of wires going in the same direction, they were made up into looms.

The idea of having many of the interconnections made by conductive tracks on an insulating board ("printed circuit", or PC board) made it possible to eliminate many of the wires and tag boards. Some of the earliest PC boards were made to accommodate valves!

Initially, the sort of components used for tag board construction were the only ones available and they were used in PC boards by bending the leads and pushing them through holes where they were soldered, by hand, to copper tracks on the board. These are still used and are known as "through hole components" – see Fig.2.

With this technique, the most expensive part of production was often the hand-soldering operation. Indeed, high-quality equipment produced in small quantities with through-hole components is still hand-soldered.

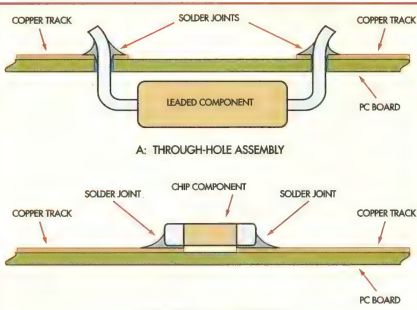


Fig.2: through-hole assembly and surface-mount assembly techniques. Note that surface-mount assembly usually requires special equipment.

Wave soldering

Wave soldering was introduced to allow consumer electronics items (eg, VCRs, radios and TV receivers) to be manufactured cheaply and in quantity.

Before assembly, the areas of the board which are not to be soldered are coated with a "solder mask" which, as its name suggests, prevents the copper underneath being soldered.

The boards, loaded with components (often by "pick and place" robots) are then placed on a conveyer system. The components are on the upper side of the board with the leads pushed through the holes and pointing down. The excess lead lengths may either be clipped off before soldering or left until afterwards.

The conveyor draws the board over a bath which applies flux and then over a heater which brings the underside of the board and the component leads up to a temperature just below the melting point of solder. From there, the board moves over a bath of molten solder which is pumped to form a wave of the liquid.

The crest of this wave comes in contact with the underside of the PC board, which stays in the wave just long enough for the tracks and the leads to reach a temperature above the solder melting point. Solder then flows over the tracks and leads and completes the joints.

Finally, the conveyor takes the soldered board away from the solder bath.

Sometimes the board is simply allowed to air-cool but there are some processes which actually drop the whole PC board into a bath of cold, fresh water. This has the added feature of "shocking" the soldered joints, revealing any weaknesses or poorly soldered joints.

If the component leads have not been pre-cut, the cooled board is then taken through a saw which trims all the leads to the required length.

For wave soldering to succeed, flux, preheating and solder flow adjustments are all critical. The board itself must also be carefully designed so that solder bridges do not cause shorts. It takes experience to get good results.

Reflow soldering

Another technique called reflow soldering is used where complex circuitry and high volume are involved. (Did anyone mention computers?)

This makes use of special "surface mount" components and requires a substantial investment in plant and operator training. As such, it is not a technique that's suitable for home con-

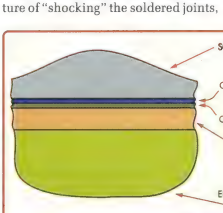


Fig.3: solder works by combining metallurgically with the surface of another metal to form very thin, brittle intermetallic layers. It is these layers which actually form the electric and mechanical connections in the soldered joint.

If you're worried about fumes from soldering, this powered fume filter from Altronics could be the answer. It is designed to suck the air in from around your work and filter it, so you dont breathe in the fumes.

struction but it should be mentioned that there are special hot-air-flow hand tools available for attaching and/or replacing surface-mount parts.

Increasingly, there are components that are available only in surface-mount versions and the serious home constructor may well wish to use them. Mostly, they are smaller than similar through-hole components and keen eyes (or a good magnifying glass!) and steady hands are needed to place even a small number on a PC board.

For professional assemblers, a wide range of resistors, capacitors, transistors and ICs is available. Indeed, most components are now available in surface-mount packaging and some exclusively so.

In principle, the idea of reflow soldering is very simple. A paste made up of fine particles of solder and flux is placed on the tracks where the solder joints are to be made (probably tin-plated copper). The component leads are then placed in the paste, heat is applied from above and the solder paste melts (its flow being assisted by the flux) so that it forms a bond between the component lead and the track.

In practice, it is somewhat more complicated than this. Three expensive machines are required: a screen printer, a pick-and-place machine and a reflow solder machine.

The paste is applied to the PC board by a screening process similar to that used to screen-print signs or T-shirts. The screen may be made of metal rather than silk in order to maintain precise dimensions and handle the solder particles mixed with the flux.

The paste is thick enough to keep the components in place while the board is transferred from the pick-and-place machine to the reflow solder machine.

A PC board may have hundreds (if not thousands) of components, each of which has to be placed in an exact position. Often, polarity is important as well. The components are supplied on a continuous tape that is wound on a reel – maybe several thousand components on each reel. The machine can usually handle a number of reels at the same time, pick the components from the tapes and place them in precisely predetermined positions on the board.

In the solder machine, the carrier moves the board slowly through the several stages of the process. The time

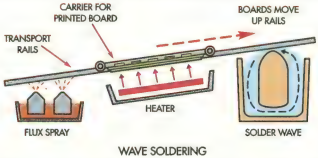


Fig.4: the basic principles of wave soldering – see text. Compare this with the wave soldering system shown in the photo on the facing page.

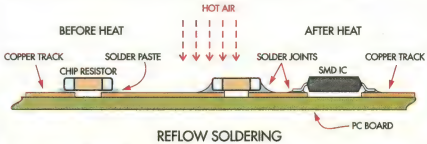
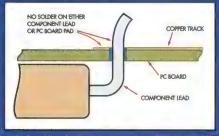
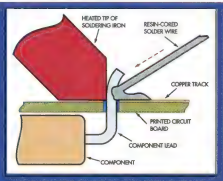


Fig.5: reflow soldering doesn't use a soldering iron at all – temperature-controlled hot air is used to melt the solder "paste" applied to the component and copper tracks to be soldered. The board passes through the hot air, the solder paste melts and presto – a soldered joint.

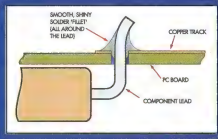
Before soldering



Looking through the PC board, with the components on the bottom, here's the lead ready for soldering.



Notice how the tip is applied to both of the bits to be soldered at once and not to the solder?



Here's what you're aiming for: a bright, shiny fillet-shaped solder joint which has taken to both surfaces.

taken for it to emerge complete and soldered is in the order of 10 minutes.

During the first few minutes, the board is raised to a temperature of about 100°C and held at that temperature to ensure uniformity. At this temperature, the flux surrounding the solder is activated.

Further into the machine, the board is brought up to a temperature of about 170°C and held again, to make sure that the heat distribution is even.

The board then moves on via the conveyer to the soldering phase where the temperature increases to around 215°C (30°C above the melting point of solder) and held at this for a period that can be from a few seconds up to one minute, depending on the components. As it mover further along, the assembly is allowed to cool naturally and comes out of the machine only a little above room temperature.

There are a several different methods currently used in the industry to provide the heating but the general trend is to use a forced hot-air flow.

Not only does the time and temperature of the reflow soldering process have to be carefully controlled but the design of the PC boards requires considerable care and experience. For example, the solder pads used for surface-mount components have to exactly match the components. Provided this is done, the surface tension of the molten solder will pull the components into their exact positions during soldering.

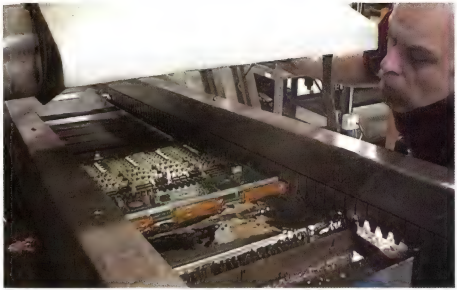
SMDs for the hobbyist

At this point, it is appropriate to consider the idea of soldering surface-mount components when they are used in home projects. For ICs and transistors, where there is a short lead with some flexibility, a very fine solder tip and a steady hand can result in good work.

The problem arises with surface-mount resistors and capacitors, most of which have a ceramic base. You can usually solder one end of the component to the PC board with no problems but when it comes to soldering the other end, the cooling process places the component in a state of mechanical stress. This raises and the possibility of breaking the ceramic body and hence ruining the part.

This stress does not occur when both ends of the component cool down together. Be aware of this problem if using an ordinary soldering iron to attach surface-mount components: always check each component after it is in place.

SMD resistors and capacitors have the advantage of low series inductance (important when working at VHF and UHF) but when this is not a consideration, it's usually easier to stick to components with leads.



Here's wave soldering in action. The PC board is carried along over the solder bath by a conveyor. At one point, the solder is forced up in a "wave" so that the bottom of the board passes through it. The components and copper tracks are soldered and the board then emerges from the bath. Photo: Ohio State University.

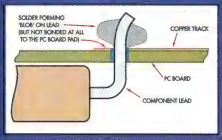
Health considerations

Finally, a reminder: solder contains lead and lead compounds are poisonous. There does not appear to be any hard evidence that people doing occasional hobby or service work are exposed to any real health risks although on production lines, an exhaust fan is often used.

Commonsense would suggest that you avoid breathing the vapours given off when soldering. Likewise, fumes from molten flux should also be avoided.

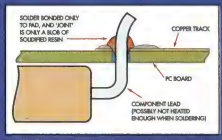
Finally, always wash your hands after soldering, especially before eating. Provided you follow these simple precautions, you should have nothing to worry about. **SC**

"Dry" joint no. 1 . . .



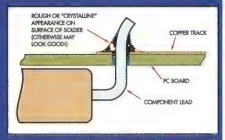
Oh no! The solder hasn't taken to the PC board track at all - it's just made a blob on the lead. This is a "dry" joint.

"Dry" joint no. 2 . . .



Here's another type of dry joint. Some solder has taken to the PC board but only flux has stuck to the lead.

A brittle joint . . .



Not a "dry" joint but one destined to fail. It is brittle because something has moved as the solder hardens.

This circuit has HEART!

The PICAXE circuit this month approximates animal breathing and heart beats to such an extent that it seems almost alive!

by Stan Swan

THIS PROJECT AROSE while discussing heart and breathing rates with a sports medicine workmate. It quite convincingly generates both "heartbeats" and breathing sounds that alter with temperature.

Left in a darkened room, it could easily convince the gullible that it's a robot taking a snooze!

For the medics (and non-medics) amongst you, the three variables widely known as TPR (Temperature, Pulse, Respiration) are perhaps the most fundamental "what's up with the patient" nursing vital signs measure. As an example, check your own pulse and breathing rates, both while exercising and relaxing.

The "heartbeat" LED effect is quite entrancing, since it slowly increases in brightness to a maximum, then fades away again to darkness.

A normal flashing LED of course just turns on and off , with no dimming action. The beating action here looks most eye-catching in comparison.

It could even be used as a status light in a more professional application, perhaps to add a "human touch" to some otherwise bland piece of equipment. You may even feel more affectionate towards your photocopier if it was fitted with one of these heatbeat circuits!

Incidentally, while this is a quite simple, indeed simplistic, type of project, it does point towards some of the "grown up" uses for this type of circuit in the real world. Many devices use visual and aural indicators to help us humans quickly work out what they are doing – you can easily envisage this type of circuit being adapted for such a purpose.

The sensor

The sensor used – a negative temperature coefficient (NTC) thermistor – has a resistance that *decreases* as the

Even the one-eyed cat was convinced . . . it was fascinated by the breathing sound but couldn't quite find the person to whom it was attached.

temperature *increases* – and vice versa.

This action is, of course, similar to an LDR as we used last month – (low resistance in bright light, high in darkness). However, thermistors have nothing like the rapid response or resistance range of an LDR, so the effects are somewhat slower and less dramatic.

Typically, an NTC thermistor such as the 100kΩ @ 25°C type used here (Dick Smith Cat. R-1895), shows a resistance of about 300kΩ near 0°C, reducing to about 30kΩ when warmed to 50°C.

A suitable voltage divider network again exploits this so that a varying voltage from the thermistor is fed to the pin 1 I/O channel input – see Fig.1.

Suitable juggling of the "top half" resistor to 15kΩ yielded some six discrete steps over a 0-50°C temperature range. If you use thermistors other than the 100kΩ @ 25°C type specified here, you may have to alter this resistor – a resistance wheel greatly eases the fine tuning.

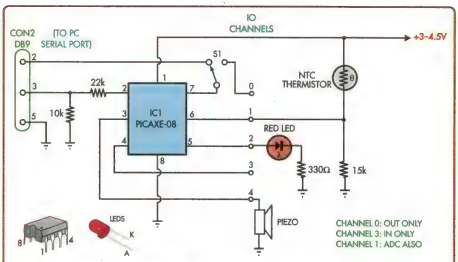


Fig.1: without wanting to sound repetitious, you can instantly see the similarities between this month's circuit and the previous two: a thermistor replaces the LDR in the input "voltage divider".

Pulse width modulation

The PICAXE-08 can output a Pulse Width Modulation (PWM) signal that effectively generates analog voltages (0- 5V) from digital inputs – in effect a simple Digital-to-Analog Converter (DAC).

Rather than a neat train of fixed width pulses, a "noisy" jumble of 0s & 1s is produced instead. However, the overall ratio of highs to lows is as specified by the duty cycle.

Quite elegant uses of this analog output can result, such as capacitor charging (and refreshing) to a desired level but the "heartbeat" use here just illustrates the PWM action and syntax. (PWM will also be used in a later PICAXE circuit involving a small DC motor driven via a transistor).

The program

Perhaps the most obvious program need is to prevent the LED action briefly halting while the piezo sounds. It's rather like your heartbeats ceasing when you breathe! "08s" execute program instructions sequentially, so this may be hard to overcome, however.

Ample memory space is left for your own tweaking, with any number of refinements possible! Wider temperature ranges can be organised by a warm lamp or cup (try to keep water drops off the electronics of course) or by placing the unit in the fridge.

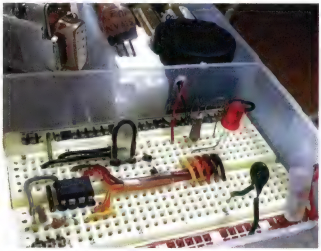
Be sure to alert your family first though, to avoid "there's something breathing in the fridge" concerns.

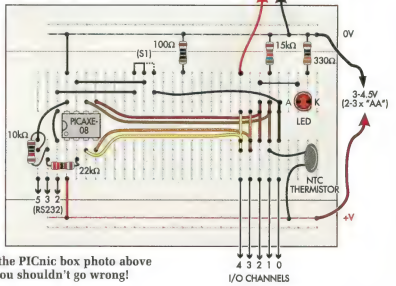
Footnote

Some users report PICAXE programming may be unreliable using *fresh* battery packs, since the upper 6V operating voltage may then be significantly exceeded.

Removing a cell or two, so that only 4.5V or even 3V is supplied, seems to overcome this problem.

See over for program listing.





Once again, we've made a few changes (for clarity) from the PICnic box photo above to the Protoboard layout at right. Follow the layout and you shouldn't go wrong!

PICAXE-08 COMMANDS USED THIS MONTH: PWM

PWM syntax takes the basic form – *PWM pin, duty, cycles*
(duty & cycle can be program variables or constants).

Pin refers to the PICAXE I/O output pin (0 ,1, 2, 4).

Duty (0-255) specifies the analog level desired (0-5 volts).

Cycles (0-255) specifies the number of cycles (~5ms) delivered.

Example: PWM 1, 100, 8 refers to the pin 1 I/O channel, 100/255 duty, 8 cycles (ie, 100/255 = 39% duty cycle; hence 39% of 5V = 1.96V output).

BASIC PROGRAM LISTING

(This can also be downloaded from http://picaxe.orcon.net.nz/heartled.bas)

```
' Demo PWM "Heartbeat/breathing " PICAXE-08 April.03 SiChip Ver 1.0 14th Feb.03
' Best assembled & tested with solderless "PICNIK" box as detailed SiChip Feb.03
' Refer http://picaxe.orcon.net.nz for background info & potential of PICAXE-08
' Extra parts = 100k NTC thermistor (DSE R-1895),Red LED, 1 x 15k ,1 x 330 Ohm
' NTC can be moved off board, but water proof(epoxy/hot melt glue ?)if outdoors
' New commands here = PWM , SOUND 255 (=hiss),
' Ref.PICAXE prog.editor.pdf help files,& BASIC Stamp 1 manuals for insights
' via Stan. SWAN (MU@W, New Zealand) => s.t.swan@massey.ac.nz <=
'-----------------------------------------------------------------------
' Byte b0= NTC measure-increases as temp rises b1= loop counter 0-255
' Variables b2= divided NTC measure (approx.= R)      b3= "heartbeat" delay
'             b4= loop counter 1-6 to give suitable pulse/respiration ratio
'-----------------------------------------------------------------------
' Lines beginning ' are program documentation & could be ignored if need be.
' Program available for web download => http://picaxe.orcon.net.nz/heartled.bas
'-----------------------------------------------------------------------

heartbeat:                      ' LED/PWM thermistor resistance monitoring routine
                                ' approximates human TPR heartbeat & breathing!

for b4=1 to 6                   ' cycle heartbeat loop so approx 10 breathes/min
readadc 1,b0                    ' low res.read NTC value via 15k voltage divider
                                ' sub zero temps may give b0=0 & beating ceases!
b2=b0/4                         ' divide for a conveniently smaller step value
debug b0                        ' show variable NTC value(s) to attached PC VDU

for b1= 0 to 255 step b2        ' counter loop so LED has multiple PWM cycles
 pwm 2,b1,1                     ' PWM pin 2 LED one cycle increasing pulse width
next b1                         ' effect is a pleasing surging brightness increase

for b1= 255 to 0 step -b2       ' When warm b2 decreases so step less/beat faster
 pwm 2,b1,1                     ' PWM pin 2 LED one cycle decreasing pulse width
next b1                         ' gives a fading brightness instead of sudden off

b3= 100/b2 *10          ' "invert" NTC b2 value & limit to a useful range
 pause b3                       ' delay decreases as temp rises
next b4                         ' continue heartbeat loop until time for breath!

sound 4,(255,80)                ' inhale = breathe in "hiss" approx. 1sec
 pause 400                      ' hold 400 millisecs (seems ~normal ?)
sound 4,(255,40)                ' exhale = breathe out "hiss" approx. 1/2 sec

  goto heartbeat                ' repeat routine
```

Some more references and parts suppliers

1. **http://picaxe.orcon.net.nz – author's enthusiastic PICAXE-08 web page.**
2. **http://picaxe.orcon.net.nz/heartled.bas – program listing to copy & paste.**
3. **http://www.healthmedialab.com/html/president/mckin3.html – a fascinating 1901 TPR chart of then US President McKinley, recorded while he was hospitalised with gunshot wound complications.**
4. **SILICON CHIP, February & March 2003 – introducing PICAXE circuits.**
5. **www.cpemma.co.uk/pwm.html – typical of web sites explaining PWM.**
6. **Dick Smith Electronics stock 100kW/25ºC NTC thermistors – Cat. R-1890 or R-1895.**
7. **Dick Smith Electronics have large (heart sized?) 10mm red LEDs – Cat. Z-4060.**
8. **Oatley Electronics (www.oatleyelectronics.com) and Microzed (www.microzed.com.au) now stock PICAXE-08 ICs and many accessories.**

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SWITCHING SOLAR REGULATOR KIT: This easy to assemble kit is designed to efficiently charge batteries from solar cells. It has charge / discharge indicator LEDs. Kit contains PCB plus all on-board components. KIT PRICE: (K008B)$15

10 LED LAMP KIT: This kit uses 10 Ultra-bright LEDs (equivalent to around 6W incandescent) with far less current drain than normal incandescent light bulbs but with a brighter, whiter light. It uses a constant current circuit & draws 120mA. (This means is your get many more hours of light with a smaller & cheaper battery & solar cell. Kit contains a small PCB, 10 White Ultra-bright LEDS & all on-board components. Easy to assemble. 10 LED Kit $20 **(K199_10)**

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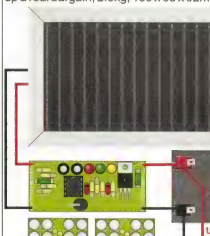

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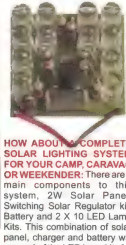

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VINTAGE RADIO

By RODNEY CHAMPNESS, VK3UG

The AWA R154 Battery Console

Intended for use in country areas without mains power, the AWA R154 battery console was first sold in 1935. It operated from three different battery types and there were no less than 11 battery leads to hook up to the chassis.

Back in April 2001, I wrote about Keith Lang, an enthusiastic vintage radio collector in Western Australia. Recently, I had a chance to renew our association during a trip to the west in late 2002.

Keith has many fine examples from the bygone era of Australian-made radios. I asked him which set was his favourite, to which he replied: "I have no particular favourite but my favourites are the Australian made sets".

The AWA R154

One of Keith's favourites is an the AWA R154 console that takes pride of place in the lounge room. This set (and the re-badged Bandmaster 365B version) appeared on the market in 1935. It had an RF stage and as such, was intended to operate in remote country areas.

The R154 and sets like it used a 2V lead acid accumulator (A supply), three 45V batteries (B supply), a 9V tapped bias battery and a 4.5V bias battery (C supply). It was a bit of a nightmare connecting all the batteries into circuit, as in this case there were 11 leads. Thankfully, they were all labelled (see photo).

For the unwary owner, there was the ever likely chance of connecting the leads incorrectly, with the possibility of burning the valve filaments out. The 2V cell (battery) was charged as necessary by the mechanic at the local garage, while the B and C batteries were simply replaced when they went flat. In practice, the 2V cell had to be recharged several times before it became necessary to replace the B and C batteries.

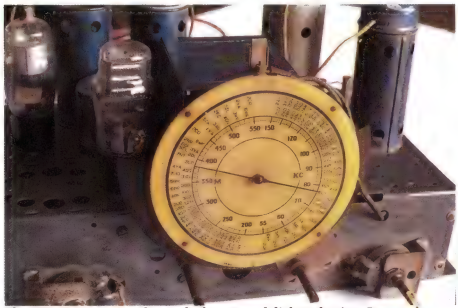
In fact, the C batteries often lasted their shelf life, as negligible current was drawn from them in most receivers.

No mains power

Not many farming communities had access to the 240V AC mains supply back in 1935. This meant that, once outside the perimeter of the townships, you were very much on your own when it came to providing electrical power. The "well to do" often had their own power supplies which usually took the form of a 32V lighting plant. However, most farmers couldn't afford that luxury, hence the use of battery receivers.

For example, my parents lived about 4km from the nearest town with 240V AC power. This meant that, in 1948, when they replaced their "Wimmera" console (similar in power requirements to the AWA R154), they chose a 6V HMV vibrator receiver.

In fact, my parents relied on kerosene lights until they installed a 32V lighting plant in 1949. But even at that stage, not many 32V sets were available and most people either relied on battery sets such as the R154 or the later vibrator powered sets.



The AWA R154 receiver featured a large round dial mechanism. It not only indicated the tuned station but also the tuned frequency (in kilocycles) and the wavelength (in metres).

R154 circuit details

Fig.1 shows the circuit of the R154

Above: the top of the set carried the controls and dial scale. The set is a good performer and is well worth restoring.

Right: this photo shows Keith's fully restored AWA R154 console. This particular unit has been converted to mains operation, to avoid battery hassles (see text).

– it is quite conventional with one or two unusual quirks.

For example, the tuning gang is mounted on rubber insulation which isolates it from the chassis. This is necessary because the gang is nominally at -4.5V with respect to the chassis (this is the bias applied to the two 34 valves). AWA did this with a few of their sets but the reason for this and its advantage, if any, is unknown.

The various stages within the receiver have the appropriate voltages applied to them via taps on the battery supplies. There is very little in the way of decoupling between stages but the receiver is stable in its operation just the same. That so little decoupling was used is an indication of the relatively low gain of individual stages. In addition, the battery supply itself was used as a decoupling medium.

RF stage

The input stage is a conventional tuned radio frequency (RF) stage using a 34 valve, followed by a 1A6 as a converter. It covers the tuning range from 550-1500kHz, as can be seen on the dial scale.

The intermediate frequency (IF) stage operates on 175kHz and uses another 34 as the amplifier. The IF output is then fed to a 30 triode which is used as a diode detector. Its output is applied to volume control R4 and from there to a 32 which functions as the first audio amplifier stage. This is then followed by a 33 audio output stage, which gives about 0.5W of output – quite adequate with an 8-inch loudspeaker mounted on a substantial baffle board. A tone control (R9) is included between the 32 and the 33.

The purpose of R2 across the volume control is not clear at first glance. Usually, the C battery positive goes directly to chassis as happens with the bias battery (a). However, this set has two bias batteries and the second one (b) applies -4.5V to the front end of the receiver as a standing bias via R2 and R4.

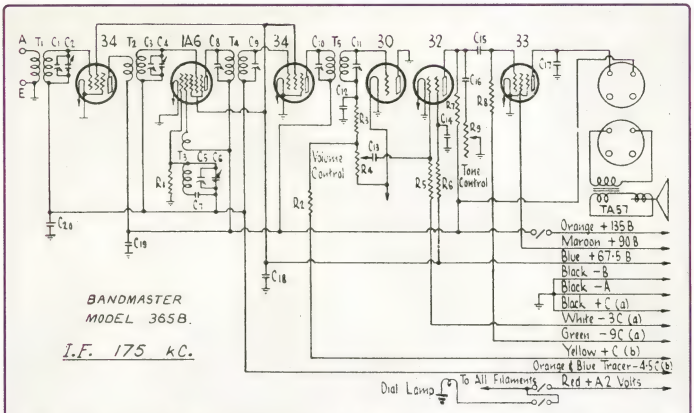
In operation, the detector develops a negative voltage across R3 and R4 that increases with the signal strength. This voltage is effectively in series with the bias voltage and so the RF and IF valves have their amplification controlled via the automatic gain control (AGC) circuit.

Apparently, designers hadn't solved the problem of minimising the number of batteries and tappings on the batteries at that stage. As mentioned earlier, there are 11 battery leads in this set – a recipe for disaster in the hands of non-technical users.

Restoring the R154

There's no risk of the chassis falling out of the cabinet in this set – it's secured in place using 6mm-diameter bolts! Before removing the chassis, it's first necessary to remove the knobs, the various battery cables and then the chassis mounting bolts.

Because the chassis is mounted almost vertically, removing the last bolt (or refitting the first bolt) can be rather difficult. The way around this is to lay the set on its front on a blanket. That way, the chassis will remain in place



"Bandmaster" Battery Operated Broadcast Console Model 365B

Fig.1: the circuit diagram for the Bandmaster 365B is the same as for the AWA R154. The set used six valves: a 34 RF stage, 1A6 converter, 34 IF amplifier, 30 detector, 32 first audio stage and a 33 audio output stage.

This rear view of the chassis shows some of the non-original valve shields that had to be pressed into service to complete the restoration.

when the last bolt is removed and it can then be lifted out.

Keith found that the antenna coil had been destroyed by lightning and so it had to be replaced. The original one was unavailable, so a midget Q-Plus car radio type was fitted inside the original coil can. The set works very well with a short antenna.

The 1A6 converter was also faulty but its replacement wouldn't work either. As a result, Keith decided to replace it with a 1C6, which worked reliably. According to Keith, the 1A6 was always an unreliable valve and the 1C6 was designed to replace it.

Some of the valve shields were also missing and the correct ones were unavailable, so it was necessary to use whatever would fit. These will be replaced further down the track if the correct shields can be obtained.

Another job involved the loudspeaker which had quite a few holes in its cone – presumably due to silverfish. These were repaired by sticking medical paper tape over each hole or tear, then gluing from the back with

Photo Gallery: Goblin Model CR Mantel Radio

Introduced in 1947 as the "Time Spot", this unusual 5-valve 3-band radio featured an 8-inch Plessey speaker and a clock-timer unit (lefthand dial). The set is actually a Goblin Model CR and was made by the British Vacuum Cleaner Company (England). It was obviously intended for export to Australia, as the dial scale is embossed with Australian stations.

The clock setting was activated by a shaft at the rear and by a large-diameter thumb-wheel on the front (between the two round dials). A similar wheel was used for the volume control, a peephole in the dial scale showing the setting.

This particular unit was been fully restored by its owner, Maxwell Johnson, Kingston, Tasmania. (Photo: Ross Johnson).

water-based craft glue.

Unfortunately, the silverfish had also attacked the outer rim of the cone. This damage was fixed using pieces of tissue paper which was covered with glue and rolled into shape around the outer rim of the cone.

The speaker baffle was also replaced but had not been finished at the time of writing. The baffle should be matt black in colour and a variety of finishes can be used here – either matt black paint in a pressure pack, or black boot polish or even good old-fashioned stove polish (eg, Busy Bee and other brands).

Cabinet restoration

The cabinet needed some attention too. Keith has not had good results with paint stripper and prefers to remove the old finish mechanically using a sharp paint scraper and a sander. You have to be careful when doing this though, otherwise the thin veneer will be sanded through.

Once the sanding had been completed, black Wattyl Craftsman traditional interior wood stain was used to highlight the edges (as had originally been done). The cabinet was then sprayed with clear lacquer to get the fine finish apparent in the photographs.

Unfortunately, the set came without knobs so Keith fitted some general-purpose AWA knobs which should be similar to the originals.

Alignment

The alignment of the receiver was accomplished without any problems.

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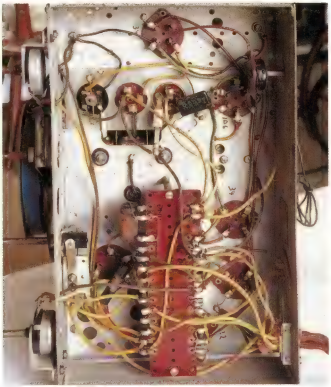
The chassis was mounted vertically in the cabinet, above the baffle (not the original) and the loudspeaker. Note the bunched battery leads and the added AC power supply (in the black box on the righthand side).



This under-chassis view of the R154 show the paucity of components and the ready access to the circuit. The only drawback is that some components are mounted on the underside of the terminal board.

The plate tuning trimmer in each IF transformer is at 135V with respect to the chassis, so care was needed to make sure that no short circuits occurred during the alignment procedure.

By the way, this set is generally easy to restore, particularly underneath the chassis. Everything is well spread out and there isn't a lot underneath the chassis anyway. If only this was true of other vintage radio receivers – some of them can be quite difficult when it comes to gaining access to various parts.

Like many sets of the era, a large terminal board was used in this receiver. The components are mounted in bulk on this board which is then mounted and wired into the receiver. Unfortunately, some of the components are mounted under the board, which is fine until service work is required.

The leads running under these boards usually have to be carefully traced, as they don't always go where expected. Unfortunately, the wiring in older sets was often run using just one colour, which made lead tracing more difficult.

That said, only a few components had been replaced over the life of the set and none in recent times. It says a lot for the reliability of most of the components.

240V AC operation

Although originally designed as a battery set, this particular set has been converted to operate on 240V AC. Keith says that even battery sets should be able to be used – even if the batteries to operate them are no longer available.

As can be seen in the photograph of the back of the set, a black box has been attached to the side of the cabinet. This box contains a power supply that provides all the DC voltages necessary to operate the receiver from the AC mains.

This particular supply was made from a kit but Keith has also made a number of supplies to his own design and all work well. The 11 power leads are wired to two plugs, so that they can be easily plugged into the power supply with no confusion as to where each lead should be connected.

Summary

The R154 (and the Bandmaster 365B clone) are sensitive receivers and the audio quality from them is quite good. They would certainly have looked the part in a 1930s or 1940s lounge room and there is much to like about them.

There are also a few features I dislike. First on the list is the great tangle of power supply leads from the batteries.

The second feature I dislike is the "floating" gang. It appears to serve no useful purpose and makes for more complexity in manufacture. And third, I'm not too keen on the way some of the components have been mounted on the underside of the terminal board.

Some of the valves may now be unobtainable for a set of this age, so substitutes may have to be used. For example, the 33 could be quite easily replaced with a 1D4 with minor alterations to the voltages applied to it.

A 1L5G could also be used if the valve socket was changed to an octal socket.

Substitutes for other valves could be found as well. It is just a matter of checking which valves have similar characteristics to those requiring replacement.

Overall, these are good receivers which are well worth restoring and having in a collection. SC

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DIY 300W car amplifier not practical

A friend showed me a back issue of SILICON CHIP and I was interested in the specs for the 300W amplifier. Is it stable at 2Ω? If not, is it a matter of doubling the output stage to obtain greater stability. I'm interested in using it together with a switchmode power supply in a car. (A. B., via email).

● We have not described a 300W amplifier although we did describe a 350W Mosfet amplifier in 1994 – it was not suitable for 2Ω speakers though. EA described a 300W amplifier back in April/May 1995 but again, not suitable for 2Ω. Finally, a 300W module was published in EA in May, June & July 1980 but it also was not suitable for 2Ω.

In any event, if you are going to install it in a car you need a high-power inverter to produce the DC supply rails of about ±80V. By the time you do that it is definitely cheaper to buy rather than build. Have look at the car amps available from Jaycar.

How to increase Multi-Spark voltage

I am interested in building the Multi-Spark CDI project from the September 1997 issue of SILICON CHIP. I was wondering about modifying it slightly. I'm wanting to increase the primary voltage from 300V to around 425V or so. Is this possible? The reason for this is to increase the output energy from 45mJ. Most commercial units put out 420V to 525V for the primary. (S. M., Invercargill, NZ).

● The voltage can be increased by another 75V using an extra 75V zener in series with ZD1-ZD4. We do not recommend going above this voltage as the capacitor is not rated for more volts. You will need to add about 50 more turns on the secondary of T1 as well.

Degaussing circuit explained

Could you tell me the function of the dual posistor in a TV set as mentioned in the Serviceman NEC TV set story featured in the September 2002 issue? (C. D., via email)

● The posistor is a positive temperature coefficient (PTC) thermistor connected in series with the degaussing coils around the periphery of the CRT. When cold, the posistor has a low resistance and this lets current flow in the degaussing coils. After a few seconds the posistor heats up, its resistance goes high and cuts off the degaussing current.

DC supplies for headphone amplifier

First, I have a small complaint. A lot of your kits do not specify (in advertisements, etc) what power supplies are required. A frustrating case in point is the headphone amplifier from the May 2002 issue.

It suggests that this kit is suitable as a general purpose headphone amplifier. My intent in purchasing was to adapt it to the output of my PC as a booster for my headphones but the requirement for ±15V was not immediately evident from the kit packaging. Nor is it covered very well in the magazine article. I find this oversight more than a little vexing.

Can you advise on a suitable kit etc, that could now achieve this requirement? (R. C., via email).

● It did not occur to us that people would want to use this project with a computer. However, if you can get access inside your PC you will probably find that you have ±12V DC available and this could be used without any mods to the circuit.

Speed controller for Meccano motor

I would like to use your 10A 12VDC motor speed controller to run a 6V Meccano motor using the original 6V battery pack. Is it possible to modify this circuit to run off 6V DC? Failing that, do you have another project that can be modified for the task? (C. C., via email).

● The 10A 12V motor speed controller cannot be used at 6V as the TL494 requires more than that to provide its internal 5V reference. Our suggestion is to use is the Mini PC Board Drill Speed Controller described in the January 1994 issue of SILICON CHIP, with some slight modifications.

The 9.1V zener diode should be replaced with a 5.1V type and the 220Ω resistor changed to 27Ω 1W.

Sound card interface is noisy

I've recently assembled a sound card preamp kit from the August 1998 issue of *Electronics Australia*, with the intention to use it as an oscilloscope. After assembly, I've done all the functionality testing as per the instructions, with the equipment working fine.

The problem is that the preamp is putting out some form of background noise (ie, with no CRO probe connected), which seems to be generated in the preamp circuit. Unfortunately, this makes the unit unreliable.

Would you be able to tell me if this was maybe experienced in the circuit built by *Electronics Australia* in August 1998 and if so, what did they do to rectify it? There is a paragraph in the article referring to the LM324 chip as noisy. Is this what I am seeing? Also, there is an instruction referring to fitting a higher performance TL074 quad op amp. Will this fix the problem? (R. C., via email).

● Our sound card interface presented in August 2002 is far superior to that

presented in the August 1998 issue of EA. At the time of publication, we assumed that the kitset suppliers would automatically kill off the old project and present the new but it didn't happen.

Unfortunately, we do not know what problems were specific to the EA circuit. If you want low-noise performance, build the one published in SILICON CHIP. Note also that our article states that the "smallest voltage you'll be able to measure accurately will be in the mV range". Our prototype had less than 1mV RMS noise but that will depend on your sound card and your computer.

Speed alarm signal pickup

You have probably been asked this a hundred times before but can you tell me if it is possible to connect the kit directly to the computer for speed sensing. I have a VP Commodore with analog display speedometer. The speedo is driven by pulses from the computer. What I would like to do is use this signal instead of the magnet/coil method. (M. G., via email).

● Yes you can use the speed signal from the engine management system. The speed signal connects to the signal input on the coil input terminal on the speed alarm. The second coil input (shield connection) is left open.

Possible damage to 12V amplifier

I have recently constructed the 12V Mini Stereo Amplifier kit (SILICON CHIP May 2001). It has a few problems when it is operating. With the bass control anywhere in the boost region, the speakers start to behave strangely. Occasionally and randomly the cones violently pull downwards, and at the same time all sound is lost for about half a second.

If I pull out one of the RCA connectors (left or right channel) and have the sound coming out of just one speaker, when the other speaker pulls down, the one which has no sound coming through mimics it. There is also a lot of hiss produced, even with no input and the volume turned fully down.

The treble control does not seem to make this phenomena occur and neither does the volume. Even with the volume very low and the bass high, the intensity of the "pull down" remains the same.

In an effort to fix this problem, I have replaced IC1, the two 100µF 16V electrolytics, the two 2200µF 25V electrolytics and the 470µF 16V electrolytic. This has partially solved the problem but not fully. I have a feeling that all of this occurred when I connected the amp to a car battery and the wire sparked and the fuse blew. I am now running the unit off a 12V 3.4Ah SLA battery. (D. F., via email).

● It seems you might have damaged either the power amplifier or the op amps used for the tone controls. Perhaps changing the op amps will solve the hiss problem.

Also the amplifier requires heavy gauge wiring for the power connections between the amplifier PC board and the battery. Otherwise, the amplifier will exhibit a tendency to mute or "motor-boat" on loud signals, due the supply voltage dropping. The minimum to use is 7.5A rated wire. Replace the supply leads before you do anything else, as this may fix the problem.

Electronic wind vane decoding problem

Back in March 2000 you described an electronic wind vane with a 16-LED display. I have had the PC boards on hand for some time and have finally got around to putting the project together. But one problem has me a little confused.

At switch-on I am greeted with one LED, that being the North LED. Rotation of the Gray Code disk did not result in any other LED becoming illuminated. A quick check of the A, B, C & D inputs found them to be all low which would explain the illumination of the North LED.

The voltages on the input lines were, on average, + 0.02V (not illuminated) and +0.9V (illuminated). The inputs appear to be going high but not high enough. The application of +12V to the inputs results in all the correct LEDs on the display board lighting, proving that the decoding is working correctly.

There is around 3mA flowing through the infrared LEDs which appears OK. Any ideas as to why this is happening would be greatly appreciated. The IR LEDs I am using are DSE Z-3235 and Z-1956. (B. C. Ballina, NSW).

● The current to the infrared LEDs can be increased to provide greater drive to the infrared diodes. Use a 470Ω resistor in place of the 1.8kΩ resistor. Also, change the 10kΩ resistors for the infrared diodes to 47kΩ, to allow a higher voltage when exposed to light.

Make sure the LEDs and diodes line up for maximum light transfer. Also,

Do DVD players control 6-channel output?

The 6-Channel Volume Control in the March 2002 issue was of interest as I am at looking putting together a system with separate amps combined with a DVD player which has built-in decoding and separate 5.1 channel analog outputs, as you discuss. However I thought that at least some DVD players controlled the volume out of all six channel outputs themselves (ie, using the DVD remote vol up/down buttons), thereby negating the requirement for the additional Volume Control project.

Am I missing something or do the DVD players only control the left & right channel output volume for 2-speaker use, and the 5.1 channel outputs are all at a standard, fixed level, that would normally be handled by an integrated 5.1 channel amp/receiver?

As you may have guessed, I haven't acquired my DVD yet, only read a bit on the web and looked at some in the stores. (D. B., via email).

● As we understand it, at least some DVD players with 5.1 output can be made to control all channel outputs by going through the menus but as soon as you switch off, you lose the settings and you have to go back through the hoops again. It really is a big hassle.

However, technology moves on and you would be wise to thoroughly check the latest DVD players. Maybe some do now have this facility in a convenient format.

10A Speed Controller

I constructed the 240VAC 10A Speed Controller from the November 1997 issue and it works well. I initially tested it by dimming a light and later with an angle grinder.

Everything is fine apart from the fact that there is around 39- 40V AC between the speed controller's diecast case and the alloy blade cover of the angle grinder. I got the same result with a router. Is this normal?

The angle grinder is double-insulated and does not have an earth connection. The case for the speed controller is fully earthed correctly, as described in the instructions. I haven't been game enough to touch it – I am not sure whether or not the multimeter is misreading something?

Secondly, are the motors in vertical press (Ryobi) drills brush type? (A. P., via email).

● The reading you are measuring will be due to the fact that the power tools are not earthed and that there is some capacitance between the metal parts and the internal wiring. The meter will read a voltage due to its high input impedance.

Try connecting a 10kΩ resistor between the multimeter terminals and do the measurement again. You should get a very low reading. Your speed controller is probably working completely normally.

Drill presses usually have induction motors, which are not suitable for use with this speed controller.

make sure the gap between the LEDs and infrared diodes is at a minimum.

Kill switch for rev limiter

I have built a rev limiter from the April 1999 issue but I also need to have a switch which will kill the engine completely. The car is used for motor sport where a kill switch is required by the regulations. It seems that this can be incorporated in the ignition switcher circuit in the following two ways.

(1) Installing a second capacitor at C1 which can be switched in to kill a very high number of sparks, causing the engine to stall; or

(2) Install a switch between terminals 8 and 3 of IC1. When the switch is closed, transistor Q3 will be turned on to kill all sparks. Solution 2 would be easier to install. What do you recommend? (D. M., via email).

● Solution 2 would be best as it completely shuts down the ignition.

Low-cost oscilloscope probe

I am interested in building a sound card adapter kit from *Electronics Australia*, on sale at one of the kitset suppliers for $30. However, I reckon I need oscilloscope probes so that I can use the adapter, right?

When I checked prices of probes at Jaycar or Dick Smith Electronics, they were around $44 each, much more than the price of the kit. That is too much for a student budget. Can we make one probe on our own? (D. B., via email).

● We featured a low-cost, low-capacitance scope probe in the August 1989 edition of SILICON CHIP. It utilises a short length of coax cable, a resistor, trimmer capacitor and a few other bits & pieces you'd probably find in your junk box.

Door alarm uses electret microphone

I have searched all the indexes, including those on your website (excellent site, by the way) and I cannot find what I seek. It is an alarm using a microphone as a sensor. It does not operate on sound but on changing air pressure as a door or window is opened. I am certain it was in SILICON CHIP and I have every copy from issue number one but I just can't find it. Can you help? (R. C., via email).

● The article appeared in the July 1995 issue. It used an electret microphone as a pressure sensor. We can supply the issue for $8.80 including postage.

Notes & Errata

AVR ISP Serial Programmer, October 2002: there is an error on the circuit on page 75. Pins 1 & 4 have been swapped on CON3. The PC board is correct.

12V SLA Battery Float Charger, March 2003: when this charger is used with the PortaPAL (February and March 2003), the 10μF capacitor connecting to the adjust terminal of REG1 should be omitted.

Simple VHF FM/AM Receiver, December 2002: a short track is missing from the PC board, as shown on pages 88 & 90. The track should connect the junction of the two 3.3kΩ resistors and L1 with the adjacent end of the 22kΩ resistor. The corrected PC board pattern can be downloaded from our website. SC

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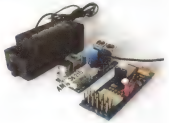

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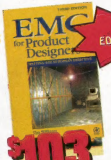

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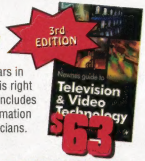

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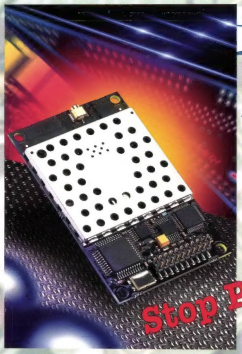

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This new 'RF-232' technology is embedded into compact AC4424 industrial-temperature 2.4GHz FHSS transceivers. RF-232 guarantees successful communication while making the process invisible to the OEM.

See the Telelink WM232-UHF 433MHz Modem Review inside this issue!

Telelink Communications have a Low Power Radio Module solution for you!

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